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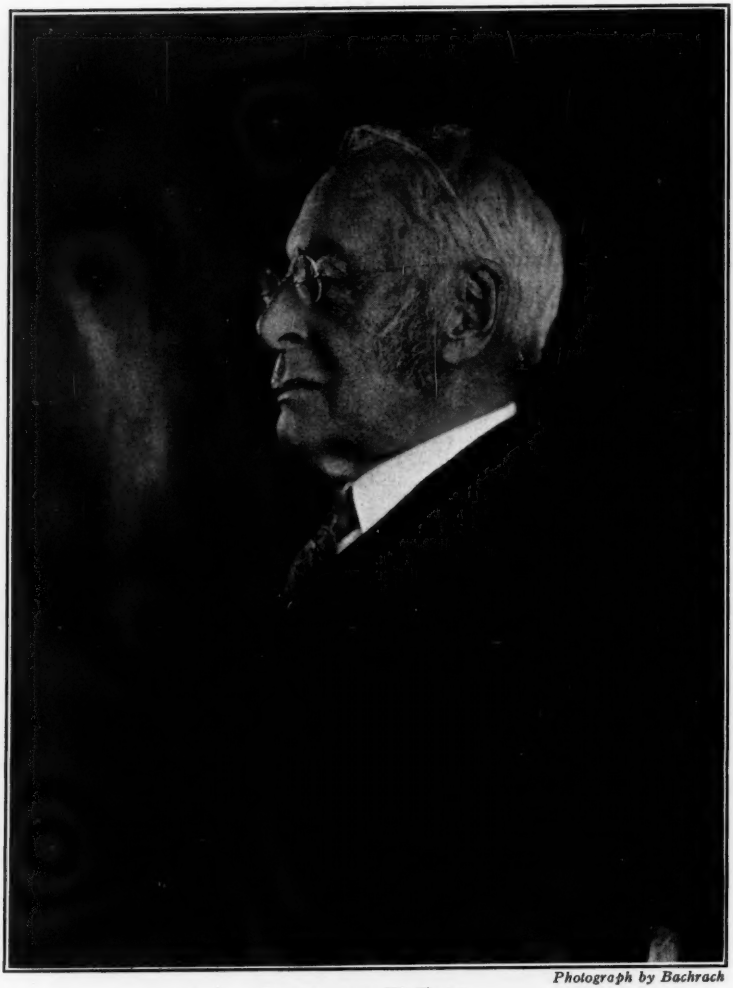


Photograph by Bachrach

DR. CHARLES W. ELIOT

EDITOR'S OUTLOOK

SOME years ago, in his "Back to Methuselah," Bernard Shaw lamented the fact that the productive life of man must terminate so soon after it begins. In his speculation upon what a truly great man might accomplish if permitted to carry on to the age of three hundred years Shaw must have had in mind some such character as Dr. Charles W. Eliot.

Dr. Charles W. Eliot

So greatly has Dr. Eliot influenced the life and thought of his times that he is known primarily as a national figure and only secondarily as a great educator. Few people remember at all that he began his career of service as a teacher of chemistry.

Since Service has been capitalized as to spelling and exploited at a price by the Rotarians and Kiwanians, and the urge to serve one's fellow man, other than commercially, has degenerated into a craving to meddle with his private affairs for the good of his soul, one expects the word to be greeted with a snicker in any connection. Yet this surfeit of pseudo-service should not blind us to the fact that the actuality for which we are driven to seek new terms remains one of the noblest of man's aspirations. A little contemplation of Dr. Eliot's conception of that actuality as exemplified in his life is an excellent antidote for a cynical attitude on the subject. This enthusiasm for service is the one common quality which he has endeavored to impart to the thousands of Harvard students who have passed under his direction.

Nor has there been anything visionary or pedantic in his teachings. On the contrary, clarity and precision of thought are among the most outstanding of his characteristics. The essentials which he emphasizes are those which every scientist acknowledges as the basis of his own creed—"a careful observation of actual facts, an accurate recording of the facts determined, and a just and limited inference from the recorded facts."

His courage of mind has often been remarked. It is well-illustrated by two telegrams which the *Nation* recently reprinted. They relate to the suspension of two students from the crew.

PRESIDENT C. W. ELIOT, Cambridge:

Is it not possible and would it not be more fitting and just to substitute another punishment for —— and —— if, as is stated, they merely took away a book which they were permitted to use in the library? It seems to us, and, we feel sure, to the great body of graduates, that it is unfair and unnecessary to make others suffer for an offense of this kind for which some other punishment might surely be found.

THEODORE ROOSEVELT
ROBERT BACON

PRESIDENT ROOSEVELT, White House, Washington:

Each man did a dishonorable thing. One violated in his private interest and in a crooked way a rule made in the common interest, while the other gave a false name and did not take subsequent opportunity to give his own. The least possible punishment was putting them on probation, but that drops them from the crews. A keen and sure sense of honor being the finest result of college life, I think the college and graduates should condemn effectively dishonorable conduct. The college should also teach that one must never do scurvy things in the supposed interest or for the pleasure of others.

CHARLES W. ELIOT

Dr. Eliot is now in his ninety-third year. We earnestly hope that he may long continue "the foremost living American."

Conscientious Idling

THOUGH the summer recess is, as a rule, far from being the period of undisturbed leisure which the average layman imagines it, most of us can look forward with certainty to some relaxation from the winter's responsibilities. Those of us who are made of that "sterner stuff" will be found in laboratories, libraries, and class-rooms. Others will welcome with delight the opportunity to groom neglected hobbies and put them through their paces. Nearly all of us, however, will manage to arrange some quiet hours of not-too-heavy reading.

Fortunately, the past few months have been very fruitful in books which may be read for the pure pleasure of it but which likewise leave one with the comfortable sense of having improved as well as enjoyed his leisure.

Those who acclaimed "Arrowsmith" will be already predisposed in favor of any work by Mr. Lewis' collaborator (or perhaps we should say adviser) in the preparation of that novel. Mr. de Kruif fully justifies that faith in "Microbe Hunters."[1] Here he has produced a series of charming, thoroughly human, biographical sketches of outstanding figures in the field of bacteriology. So brilliantly has he performed his task that even Mr. Mencken, who is seldom known to be pleased with anything, comes forward with an enthusiastic commendation.

While we are discussing biography it would be a sad omission indeed to overlook "Dean Briggs"[2] by Rollo Walter Brown. Percy Hutchinson contends that "the phenomenal success of Dean Briggs in dealing with undergraduates was probably due in no small measure to his homeliness of feature and his eccentricities of pose—the undergraduate was so diverted that unpleasant news did not seem unpleasant." Be that as

[1] Harcourt, Brace & Co., New York.
[2] Harper & Co., New York.

it may, there is undeniably something intensely interesting about a Dean of whom a student could write:

Of all the sprightly figures that adorn the college scene,
The most supremely genial is our own beloved Dean.
He'll kick you out of college, and he'll never shed a tear,
But he does it so politely that it's music to the ear.
He meets you in the anteroom; he grasps you by the hand;
He offers you the easy chair, and begs you not to stand.
"Good morning, Mr. Sporticus! How is your Uncle Jim?
I used to know him well at school—you look so much like him!
And you're enjoying college? Yes! Indeed. I am so glad.
Let's see—six E's? Impossible. How very, very sad."

Mr. Brown has done justice to his subject.

If one delights in adventure, there is William Beebe's account of the "first oceanographic expedition of the New York Zoölogical Society," "The Arcturus Adventure."[3] Does this appear to promise dull reading? Perhaps, to one who has not read Beebe's previous books. But ask yourself if the man who wrote this could ever be dull. Beebe is telling of his underwater explorations.

I once saw a giant ray, or devilfish, while I was perched on a coral throne. This huge creature actually caused a momentary eclipse as he flew close above me. Devilfish he may be because of his horns and tail and the color of his cloak, but he has a gentle soul.

The book itself is beautifully made and bound and profusely illustrated with color plates, photographs, and drawings.

Professor Durant, in "The Story of Philosophy,"[4] has produced a book which places philosophy among the possibilities for hot-weather reading. Nor should this be taken to imply a frothy or superficial treatment of the subject. As a matter of fact this book would have made an excellent text if only it had been dull enough. If a sponsor be required we may add that the signature of none other than John Dewey himself is appended to the foreword.

Professor Durant begins with an appreciation of philosophy in which he undertakes, rather successfully we think, to refute the more common criticisms leveled against it. Continuing, his plan of attack is to present each philosopher as an entirely human figure and to explain, with the aid of well-selected quotations, the essence of each thinker's system. He covers practically the entire gamut, though some are disposed of in a few lines while others are discussed at length.

His comments and observations are never frivolous, but at the same

[3] G. P. Putnam's Sons, New York.
[4] Simon and Schuster, New York.

time they are not entirely devoid of a certain pleasant levity. As, for instance, when he relates that Spinoza was jilted by a youthful sweetheart and adds that "no doubt it was at that moment that our hero became a philosopher." All teachers will appreciate the statement that the same philosopher first taught children and later polished lenses, "as if he had an inclination for dealing with refractory material."

It would scarcely be proper to close our list of suggestions without including at least one novel. Professor Herrick's history of Eureka University, "Chimes,"[5] naturally comes to mind. That this is a very thinly disguised account of an epoch in the history of a certain midwestern university, everyone agrees. One reviewer, at least, has been unkind enough to designate that university by name.

Unkind, for the reason that Mr. Herrick's novel is a merciless indictment of "Eureka" and many members of its faculty. This quite incidentally, for the author, has no need to comment upon the facts as he presents them. They are eloquent in their own right.

Be it said, moreover, that Mr. Herrick is neither bitter nor a "bolshevik." Many a professor can match characters and situations in "Chimes" out of his own experience. A book worth reading—disillusioned but not depressing

[5] The Macmillan Co., New York.

HISTORICAL NOTES UPON THE DOMESTIC POTASH INDUSTRY IN EARLY COLONIAL AND LATER TIMES*

C. A. BROWNE, CHIEF, BUREAU OF CHEMISTRY, WASHINGTON, D. C.

The manufacture of potash, which, with so many other enterprises, was quickened into activity in the United States during the recent World War, is in reality one of the earliest American chemical industries. Potash manufacture is in fact one of the oldest of all chemical industries, the process of leaching wood ashes for the soluble alkali which they contained being known to the ancient Greeks and Romans, who, however, were unable to distinguish between potash and soda, both of them being called by the general name of *νιτρον* or *nitrum*. The word potash is of comparatively modern origin and was derived from the fact that the alkaline extract of wood ashes was concentrated to a solid form in pots. It was not until about the middle of the eighteenth century that a difference began to be recognized between the two alkalis—soda and potash.

The depletion of the forests of England previous to the year 1600 caused a growing scarcity in that country of wood ashes which was the chief source of the potash used for the manufacture of soap, glass, and other commodities. The development of new means of procuring timber products—such as potash and naval stores—was an urgent industrial need in England when colonization of the Atlantic Seaboard began and so we find that the London Company, the year after it founded the Jamestown settlement, in 1608 sent eight Poles and Germans to the new colony to make soap ashes, pitch, and tar. The shipment of wood ashes from Virginia to England was begun immediately in a small experimental way and the business was increasing in importance until all activities were suddenly paralyzed by the Indian Massacre of 1622.

The disturbed conditions of Europe in the first half of the Seventeenth Century and the interruption of trade with Russia from which England obtained its principal supplies of potash, caused a rapid increase in the price of the commodity from 12 pounds a ton in 1620 to 50 pounds a ton in 1650. The stalks of peas, beans, ferns, and other vegetables were burned for their potash and renewed efforts were made to stimulate the industry in the American colonies. In an old tract upon Virginia published at London in 1650 by E. W. Gent the advantages of potash manufacture are given particular consideration and the profit to be derived from this enterprise was advanced as an argument for the establishment of colonies in Carolina and Georgia.

Sir Robert Montgomery, in his "Discourse Concerning the Designed Establishment of a New Colony to the South of Carolina in the Most

* Paper read before the joint meeting of the Division of Chemical Education the Section of History of Chemistry of the American Chemical Society at Los Angeles, August 6, 1925.

Delightful Country of the Universe" published at London in 1717, has this to say about the simplicity of potash manufacture:

> Nothing can be plainer or more easy than this practice in our intended settlement. As to the boilers, which have ever been the great and terrifying expense and encumbrance of this work, we extremely lessen and reduce that charge almost to nothing by some new methods, being an experienced invention, wherein we use neither copper, lead, iron, nor other mineral whatsoever, and (that excepted) there is no material necessary, but wood only; for wood cut down and burnt upon the ground affords the ashes; the rivers everywhere abounding in that country furnish water; ashes and water boiled together yield the lye; the lye evaporated leaves behind the salt, and that very salt calcined becomes the potash, and it is packed and sent away in barrels made and hooped there also.

As to the possible profits in American potash manufacture Sir Robert makes the following calculation:

> The wood of an acre yields two tons of potash and the whole year's labor of three men employed in cutting down and burning off twelve acres and boiling and managing the ashes, will produce 24 tons of potash, which, being a commodity of universal consumption, cannot easily overstock markets, at least not from far greater quantities of woodland than we are here talking of.
>
> The general price of such potash, being the richest and best, is from 40 to 60 pounds sterling per ton, but we will reduce it to 20 for argument's sake, though such a fall is improbable for such a commodity (some of our own English ashes which have not a fourth part good potash yielding that price or more), the 24 ton will then sell for 480 pounds. If out of this sum we allow for payment of freight and custom-house duties, etc., at the most extravagant reckoning, we may deduct on that score 180 pounds, and then out of the remaining 300—150 pounds will be due to the purchaser in England as the first year's clear profit of his hundred-pound venture and that profit will be every year growing greater and greater.

Early attempts had been made in all the colonies of the Atlantic seaboard to stimulate the production of potash for exportation to European countries. John Winthrop, the younger, presented a report upon the manufacture of potashes in New England before the Royal Society in 1662, and there are many references in colonial reports of the seventeenth century to potash manufacture. The primary need of settlement and agriculture and the lack of transportation facilities, however, prevented the first colonists from doing anything very extensive in a manufacturing way. The first attempts at making potash belonged to the class of what that early explorer, Capt. John Smith, termed "trials;" none of them could be called a profitable industrial success and one failure usually succeeded another. In New York several potasheries were set up under the Dutch régime, one of them at considerable cost, but none of them succeeded; the business was renewed again in 1709 by a London promoter but without success. The industry attained its earliest development in New England but progress was slow and it was not until 1735, according to Peter Whitney's History of Worcester, that the first

complete ton of potash was sent to market from the town of Ashburnham, Massachusetts.

One great impediment which hindered the growth of a colonial potash industry was the excessive duty that was levied in England upon all importations of this commodity. On account of the increasing difficulty of securing adequate supplies Parliament was moved in 1751 to remit the duties upon potash in order to stimulate its production in the American colonies. As an additional incentive, Mr. Thomas Stephens, at the request of Parliament, published at London in 1756 his well-known treatise "A Method and Plain Process of Making Potash" and went to America the same year in order to help establish the industry upon a successful basis. With letters of recommendation from members of Parliament and from Gov. Belcher of Massachusetts, Stephens came to Philadelphia, where, in association with Franklin and other prominent citizens, he purchased the potash works of the defunct Liverpool Company. A large furnace and other buildings were erected and Stephen's process was put in operation inside of a month in the presence of an enthusiastic audience which included Governor Denny and other notables. Stephens then went to the Rappahannock in Virginia for the purpose of starting another abandoned factory of the Liverpool Company and after that he proceeded to Georgia for a similar purpose.

As a further incentive to the manufacture of potash in America the London Society of Arts in 1761 offered a premium of 4 pounds for every ton of merchantable pearlash imported into London from the English colonies. The increasing consumption of potash for bleaching, calico-printing, glass manufacture, soap-making, and other purposes caused very marked attention also to be given to the cultivation of glass wort and other chenopodiaceous plants whose soda-containing ash under the name of barilla was used as a substitute for potash. The London Society of Arts offered premiums also for the production of barilla in the southern colonies of the Atlantic seaboard. In addition to such awards which amounted to many hundred pounds, this Society conferred fourteen honorary gold medals upon persons who were eminently successful in the production of potash and barilla. Mr. Edward Quincy, a member of the famous Boston family which bore that name, was encouraged, on the occasion of a personal visit to the London Society in 1760, to take up the manufacture of potash and six years later was able to inform its members that the business was so firmly established that it needed no further assistance from them except in the matter of assaying, detection of adulteration, and maintenance of credit.

In addition to the English treatise of Stephens previously mentioned, there were published about this time a considerable number of practical American essays upon potash and barilla manufacture which gave a

considerable impetus to the business. One of the earliest of these was a quarto pamphlet published in Boston in 1757; another published in 1765 describes the Hungarian process of calcining pearlash with an illustration of the furnace. The London Society awarded a medal in 1767 to Mr. William Lewis and another in 1768 to Robert Dossie for essays upon potash making. American societies for the Encouragement of Arts in New York and Philadelphia also awarded premiums for the production of this commodity, the general result being that the manufacture of potash was one of the most flourishing of colonial industries at the outbreak of the Revolution.

The trees which were found to give the best results in burning for potash were the hickory, oak, beech, birch, elm, walnut, chestnut, and maple. Evergreen woods, such as the pine and hemlock, were avoided. John Mascarence in his address upon the subject to Gov. Pownall of Massachusetts, in 1767, gives the following advice:

> It is supposed that each set of works for carrying on the manufacture of potash will have a range of 10 miles round for its supply, less than which would not be sufficient; and I would here, by the way, caution such who may undertake to erect works for this purpose that the place they fix upon be at least 20 miles distant from any other works of the like kind, lest they only injure their enterprise by thus cutting off the prospect of a sufficient supply of ashes.
>
> Each set of works under such advantages of obtaining stock will, I presume, at the least, annually produce 20 tons of good potash, which, at the lowest rate it has ever been sold for, namely £25, would amount to £500 sterling, and if 20 of these works were to be erected within the limits of the province of Mass. (which I think a moderate number), there might be annually exported out of the province alone 400 tons of potash, which, at the before-mentioned low rate, would amount to £10,000 sterling.

The process of manufacturing potash in the American colonies was necessarily crude and wasteful. The following description, contained in Smith's History of Pittsfield (Vol. II), is a typical illustration:

> The wood was usually cut into lengths of 8 or 9 feet; piled in heaps containing from 1 to 3 cords; and when half dry burned. The ashes were placed in large tubs whose bottoms were covered 6 or 8 inches deep with brushwood, above which was a 3 in. layer of straw. Water was then filtered through the mass, till all the soluble matter was carried off in the lye which passed through an aperture in the bottom of the tub into a proper receptacle.
>
> This lye was then placed in large iron kettles, and boiled until the evaporation left the matter held in solution in a solid form—a dark, almost black, crust, known to the workmen as brown salts having a strong alkaline taste. These salts consisted of a very large proportion of potash mixed with more or less carbonaceous matter, vegetable salts, and a little earth. This mass was thrown into a cast-iron kettle of considerable thickness, and subjected to a red heat for 1 or 2 hours and most of the combustible matter was consumed. The residuum, when cold, was broken up, packed in tight casks, and sent to market—the American potash of commerce. It contained from 5 to 25% of pure potash with impurities in various proportions, depending very much upon the care exercised in collecting the ashes after the burning of the wood.

The crude potassium carbonate, which was obtained by the above process, was frequently purified by treating the pulverized product with the minimum amount of cold water necessary to dissolve the carbonate, filtering from the undissolved residue of potassium sulfate and other less soluble salts, evaporating to dryness and again igniting. The product thus obtained was known as pearlash and, although of a superior color and purity to the crude potash, still contained a perceptible amount of potassium chloride and other more soluble substances.

While the processes of leaching, boiling, and purifying potash, as above described, were sometimes performed by the farmer, they were more generally carried out by central establishments or potasheries who paid the farmers for their wood ashes, the price, which varied above or below 6 d. per bushel, depending upon the market price of potash and the quality of the ashes. Owing to the deceptions which were sometimes practiced upon the potash establishments by the sale of leached ashes and by other frauds there was always a great need of a suitable method of valuation.

A careful review of the early American potash industry indicates that the more expensively equipped establishments were generally the least remunerative. Many persons both in England and in the American colonies, engaged in the business on too lavish a scale and suffered serious financial losses. The history of a large potash factory erected near Belchertown, Mass., is particularly instructive in this connection. An immense building was erected and equipped with numerous iron-bound vats, between which in the center were built four large furnaces, the flames of which met in a single flue where the combined heat was concentrated upon the alkaline extract that was supplied continuously in a small stream. The plan of the process was for the evaporated water to escape as steam into the chimney and for the dried potash to fall into a pan beneath, but the operation, as thus conceived, failed to succeed. When the fire of the furnaces met the stream of potash liquor, a violent explosion wrecked the chimney and the project had to be abandoned as impracticable.

In 1770 the exportation of potash from the North American Colonies amounted to 1173 tons and that of pearlash to 737 tons the value of these being estimated at $290,000. The manufacture of potash suffered a temporary check during the American Revolution but after the declaration of peace the business was resumed with unprecedented vigor owing to the encouragement of bounties offered by different states and societies.

In 1785 Governor Bowdoin of Massachusetts recommended to the General Court, as a remedy for the financial distress which then prevailed, that the farmers in towns where there was an abundance of wood to be cleared away, should devote themselves to the production of potash and pearlash and that their products should then be deposited with the State

Agent who was to sell them and employ the proceeds for paying the taxes of the owners. In 1788 the number of potash works in Massachusetts numbered nearly 250; nearly every town in New England had one or more successful potash works, some of the plants being set up at a cost of less than twenty dollars, exclusive of the iron evaporating kettles which were the chief item of expense. By the laws of Massachusetts (Nov., 1784), Pennsylvania (1790), and other states potash and pearlash intended for exportation had to be subjected to a careful inspection as to quality and packing before shipment and this contributed greatly towards maintaining the fine character of these American products.

According to the first Custom House records in the 14 months from August, 1789, to October, 1790, there were exported from the United States 7050.10 tons of potashes with a value of $661,634.00 and 1548.55 tons of pearlashes with a value of $177,459.50, these two items ranking first and third, respectively, in the line of exported chemicals. In the production of potash New York ranked first, Massachusetts second, New Hampshire third, Rhode Island fourth, and Pennsylvania fifth; in the production of pearlash Massachusetts ranked first, New York second, Rhode Island third, New Hampshire fourth, and Pennsylvania fifth.

The value of exported potash and pearlash passed the million dollar mark for the first time in 1807 when the combined amount reached $1,490,000. In 1808 during the enforcement of the embargo this combined value declined to $408,000 which represented an apparent loss of over one million dollars. The actual loss was, however, much less than this for, while the exportation of potash and pearlash from the Atlantic ports was greatly curtailed by the enforcement of the embargo, the opposite effect was produced with respect to the shipments of these products by smugglers from northern New England and New York into Canada where in consequence of the embarrassments of commerce the price of potash rose from $100 to $300 per ton. Nearly the whole population of some of the northern counties of New York and Vermont devoted their energies at this time to the manufacture and transportation of potash to Montreal. The potash industry in this region was consequently greatly stimulated by the embargo and when attempts were made to enforce it along the Canadian border there were loud murmurs of discontent which found expression in resolutions, proclamations, and even threats of resistance. An interesting picture of this situation is contained in Vol. III of Edward Kendall's "Travels through the Northern Parts of the United States," published at New York in 1809, from which the following passages are quoted:

> When, in Jan., 1808, in conversation with different inhabitants of this district of country, I inquired, how it happened, that they, of all others, amid their own representation of the advancement making around them, under the fostering influence of the embargo, were the loudest to complain and the first to oppose physical force, they usually

replied that they felt in common with the rest of the U. S.; deploring the calamities which were experienced, and detesting the policy whence they spring. But, than this account of their principles of action, nothing could be more fallacious. They had no objection to the embargo; they would have rejoiced in its existence along the whole coast of the Atlantic and elsewhere; and they would have rejoiced if it had been forever continued. It was the attempt to deprive them of those advantages which, from their local situation, they were able to derive from the embargo; it was this alone which excited their resistance or complaints.

***At all times, that is, at all ordinary times, they must experience their disadvantages; but the embargo, by closing the seaports of the United States, had presented to this people a new state of things and promised them a career of gain, to be pursued in defiance of the natural inconvenience of their situation. Exclusively of the increased demand for masts and lumber, which the state of Europe at this identical moment brought into their market and which was unconnected with the embargo, there were other occasions of profit immediately arising from it. The manufacture of pot and pearlashes is not only a source of immediate profit to the settlers in a forest, but it has the incidental effect of clearing the lands, and promoting the agriculture of the country; but, if the price to be obtained for these articles is too low, or, what is the same thing, if the market is too distant, the articles will not be manufactured; and for want of other inducement to clear the lands, the lands will remain uncleared. Now, the embargo, by closing the seaports of the U. S. had not only raised the price of the article, but had rendered Vermont, from being the point most distant from the best market, the point most near; that is, the point of the U. S. most near to an open seaport. The immediate consequence, as was said by proprietors of lands themselves, was one which is sufficiently obvious, that lands, which had remained in forest up to that moment, would now pay for clearing, by the sale of the pot and pearlashes to be made on them and were, therefore, now under the axe. The truth is, that a long continuance of an embargo would give to the northern parts of Vermont as well as to Canada and all the countries adjacent a prosperity for which they can never hope under any other system.

It was not merely, in the forced market, however, thus offered to the produce of the northern parts of Vermont that the benefits of the embargo consisted. This affected the whole of the northern parts, from Lake Champlain to the Connecticut; but there was also the benefit of the carrying trade between Portland, Boston, and New York and the Canada markets, in Montreal and Quebec, in which the northwestern parts of Vermont had an almost exclusive interest. The route lies in the district and it was of importance that this route should be kept open.

Here, then, was the source of this local opposition. The general system of the embargo had many friends; but its application to this part of the country encountered only enemies. For this part of his conduct, Mr. Jefferson's former partisans in the district proclaimed that they "viewed him with contempt"* but had he left the embargo limited, as it was at first limited, to the seaports, they would have viewed him only with admiration.

With the removal of the embargo in 1809 the value of the exports of potash and pearlash from the United States rose to the unprecedented figures of $1,506,000 in 1809 and $1,579,000 in 1810. These values, which represent the high water mark in the exportation of potash from the United States, were no doubt stimulated, as in the case of the year 1807 preceding the embargo, by the anxiety to increase shipments be-

*See the Monkton Resolutions, 11, Feb., 1809.

fore a threatening restriction of commerce. In 1811, during the transportation troubles, which preceded the war of 1812, the combined value of the potash and pearlash exports decreased to $752,000 and in 1813 during the course of the war to $204,000.

The removal of the surplus timber from available farm lands along the Atlantic seaboard and the rapid development of the Le Blanc soda process in Europe, after the Napoleonic wars, were two important factors that kept the American potash industry from regaining the supremacy which it held before the year 1810. The crude potash salts shipped from America could not compete, for many purposes, with the cheaper and purer alkali that was made from salt, and the leaching of wood ashes declined from a chemical industry of first importance to one of minor significance.

From an agricultural point of view the manufacture of potash from wood ashes constituted one of the greatest economic crimes in the history of the United States. The losses in our domestic supplies of a most valuable fertilizing ingredient, resulting from the shipment for two centuries of potash and pearlash to European countries and from the enormous wastage in the process of manufacture, are incalculable. This economic crime, however, was due entirely to ignorance. The importance of potash as a fertilizing agent in agriculture did not begin to be appreciated until its exportation from the United States had come practically to an end. The agricultural development of the Eastern United States has suffered greatly from the consequences of this error, the loss of soil fertility having forced the abandonment of many farms. But to the countries of Europe and more particularly to England, the importation of potash from the American colonies was of tremendous advantage for their industries were thereby enabled to withstand a critical period of potash deficiency.

Cod Liver Oil Prevents Decay of Children's Teeth. Expectant mothers and children of the "growing up over night" stage need no longer suffer so many dental losses. According to experimental studies made by Dr. Weston A. Price of Cleveland, doses of calcium lactate and cod liver oil not only reduce the decay of teeth at these periods but add to the well being of the whole constitution.

In a talk before the National Academy of Sciences at Washington, Dr. Price also described a series of studies with chicks to show the effects on calcium metabolism or changes that have to do with bone and tooth formation, of ultra-violet rays, sunshine and cod liver oil. He has found that the external application of raw cod liver oil to young chicks would increase the calcium percentage to such an extent as to suggest its use in this manner for curative purposes.

It was accordingly tried on the inflammatory processes of joints and found very beneficial. Its use in this way likewise produced a marked improvement in arthritis in humans and in bone and joint lesions in chicks.—*Science Service*

THE COMMERCIAL PRODUCTION AND USES OF RADIUM*

CHARLES H. VIOL, STANDARD CHEMICAL COMPANY, PITTSBURGH, PA.

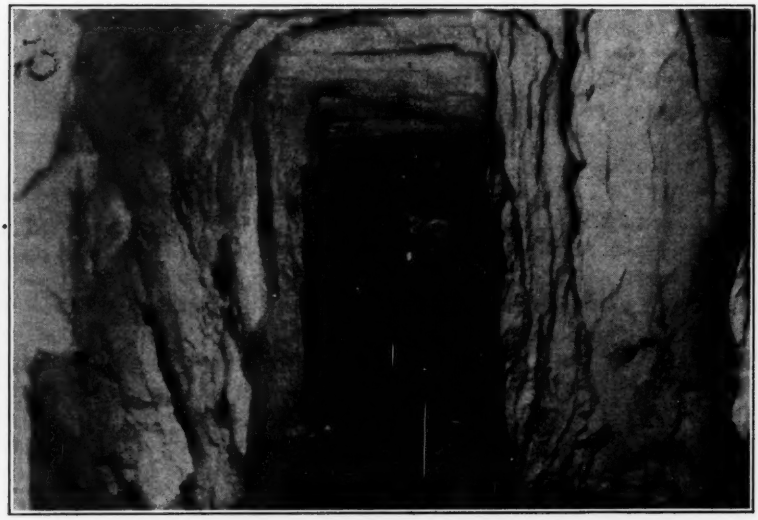
Substances that are rare in occurrence, or which have peculiar or little understood properties, often excite the general interest, and even when the veil of mystery is removed, if costliness remains an attribute, there is a continuing respect and curiosity. Radium, because of its rarity, symbolizing as it does to many, the whole group of radio-active elements, with its intense radiations taking it out of the class of uranium and thorium, with its uses in the treatment of dread disease, and with the mystery attendant to its production and the high price which it brings, has all the qualifications of a substance to excite interest.

The romance of the discovery of radium and its final purification by Madame Curie after years of brilliant and arduous labor, is only less thrilling than the wonderful vistas which the study of radio-activity has opened in many of the major experimental sciences. But with all that has been accomplished by scientific research, and all that radium has done in the treatment of the suffering, it is a fact that the world's present total used amount of radium does not greatly exceed 240 grams, or just a little more than a half pound. The production of this handful of radium has required many years of toil by hundreds of workmen and not less than 150 grams of radium has been refined in the United States from Colorado carnotite ore, the first American production of high purity radium having been made in 1913 by the Standard Chemical Company of Pittsburgh, Pa., using this ore as the source.

Since the announcement in December, 1898, by the Curies and Bemont of their discovery of a radio-active substance associated with the barium from pitchblende, to which the name "radium" was given, radium has been proven to be a transformation product from uranium and present in old uranium ores in about the proportion of one part of radium per three million parts of uranium. Due to its origin by atomic transmutation, and with segregation an unlikely phenomenon, the highest natural concentration of radium is therefore to be found in richest uranium-containing minerals. Pure uranium does not occur naturally, but its oxide, U_3O_8, containing approximately 85 per cent of uranium, makes up the purest form of the mineral with the highest uranium content (uraninite or pitchblende). A gram of radium will be found in 3.53 metric tons, or 3.88 short tons, of such purest uraninite.

In Southwestern Colorado and Southeastern Utah there is found over an area of many hundred square miles a thin blanket formation of a sandstone, cemented in part by a uranyl vanadate salt, which is called carnotite. In purer form carnotite is a lemon-yellow, talc-like amorphous sub-

* THIS JOURNAL wishes to acknowledge the kindness of the editors of *Radium* in lending the cuts which accompany this article.



Carnotite mine in Southwestern Colorado. These workings in a sandstone formation follow the carnotite seam and are often several hundred feet long.

Preparing to blast out carnotite and rock with dynamite.

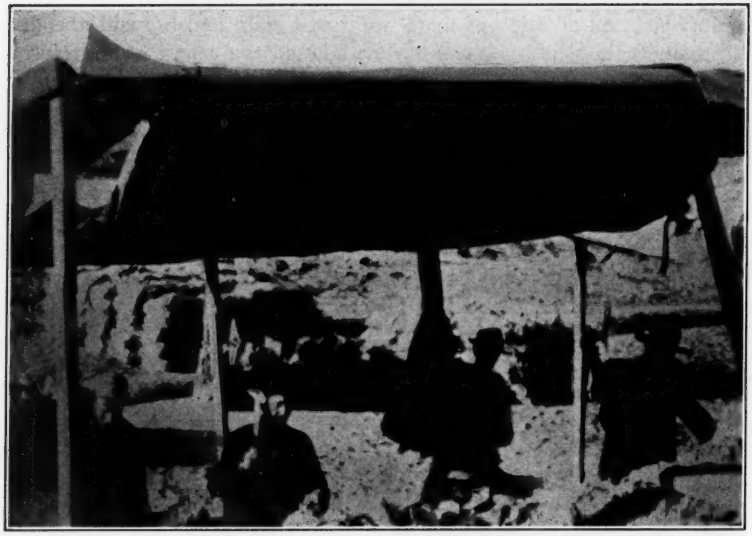
stance, but in the low grade ore, the color varies from a yellow to a greenish or red, depending upon the other cementing constituents in the sandstone. Carnotite occurs in seams of varying thicknesses, rarely exceeding twelve to fourteen inches, and the ore is overlaid with thicknesses of sandstone making the mining underground rather than stripping. Deposits are often located by the yellow-colored debris from out-croppings on hill-sides or canyon wall, and the earlier production of carnotite was made by mining from such more or less open pockets and hand-sorting, the richer material carrying an average of 2 per cent of U_3O_8. This richer ore was sacked and carried to the road on burros and thence by wagon to railroad.

In 1911, Mr. Joseph M. Flannery of Pittsburgh formed the Standard Chemical Company to undertake the commercial production of radium from carnotite ore. Mining claims were secured in Colorado and Utah and from the start it was realized that a method of mechanical concentration of the ore would be essential to large scale production. The Raymond impact pulverizer was first used for this purpose, and while this method was successful in separating the carnotite and other cementing material from the sand grains, it was finally supplanted by a wet grinding process, which avoided the dust troubles inherent to the dry method. By a great deal of attrition of the carnotite and with comparatively little crushing force, the sandstone ore was disintegrated by working it in large tanks with heavy wheels rotating in the mass of ore and water. This treatment produced a pulp which, on addition of more water and agitation, brought the fine, slime-like values into suspension, but allowed the coarse sand grains to settle quickly. On pumping off and filter-pressing the fluid, the values were recovered as a filter cake.

The filter cake carnotite concentrate is composed of a very fine powdery material carrying usually 3.5 to 4 per cent of U_3O_8, 8.9 to 10.2 milligrams of radium per ton, and 9 to 11 per cent of V_2O_5 as the possible values. In the mechanical concentration of the ore a loss of 20 to 25 per cent of the values occurs on a single concentration, although reworking the sand tails affords an opportunity of recovering half of the lost values. To secure concentrate sufficient to finally yield a gram of radium in the finished form of pure radium bromide, it is necessary to mine enormous amounts of the over- and underlying sandstone rock in following the narrow carnotite seams. Taking out as carefully as possible the carnotite and rock in the quantity of 2000 to 2500 tons, by hand-sorting some 500 tons of average milling ore may be obtained which serves as the starting point for a gram of radium. This ore carries approximately three milligrams of radium per ton, and after concentration with a loss of 20 per cent of the radium the concentrate contains about 1100 of the 1500 milligrams in the 500 tons of milling ore.

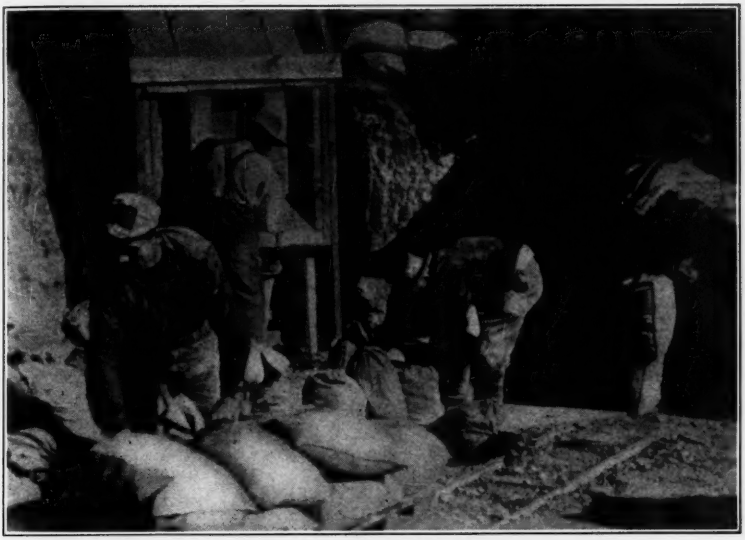
Chemically, radium is a bivalent metallic element with properties very closely resembling those of barium, and in ordinary chemical changes

Gathering up the ore and rock after the blast.



Sorting milling carnotite ore by hand from the mixture of ore and rock. The milling ore represents an average of about one-fifth of the mined material.

the radium present will quantitatively follow the barium. The first stage in the chemical treatment of any radium ore consists essentially in the separation of the barium-radium content from the other materials present. The quantity of radium present being only a few parts per billion, it is impracticable to directly extract this product and if barium compounds are not present in sufficient amounts in the material, in handling richer ores they are added in suitable quantity under conditions that will make the extraction of the barium assure the extraction of the radium. The carnotite concentrate carries barium equivalent to about 0.4 per cent

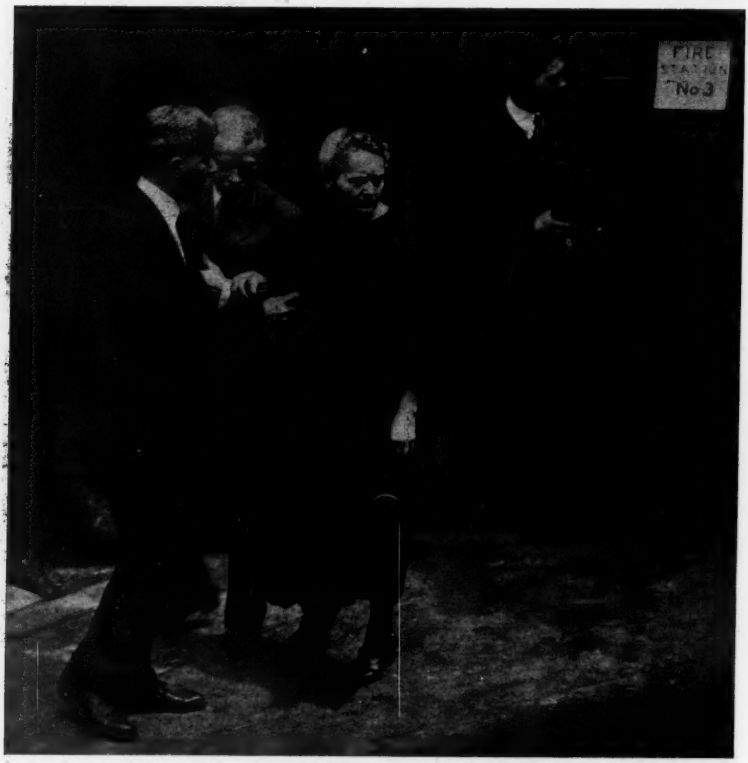


Sacking the milling ore preparatory to hauling it on burros and by wagon to the concentration mill.

of barium chloride and this quantity, while small, offers a tangible something to work with as compared with the eight to eleven parts per billion of radium.

The chemical extraction of the radium from the carnotite concentrate is made by boiling with concentrated sulfate-free hydrochloric acid. The radium and barium in carnotite are not present as sulfates and are practically quantitatively soluble in strong hot acid, which also dissolves all the other basic elements present, including uranium, vanadium, calcium, iron, etc. The hot acid solution, somewhat diluted, is quickly filter-pressed, and in the press liquor the radium and barium ore precipitated by addition of a soluble sulfate or sulfuric acid. The precipitated radiferous

barium sulfate so obtained from the concentrate of 500 tons of milling ore, amounts to about a ton. This crude sulfate of radium and barium is considerably contaminated with other basic elements, notably iron and calcium. The crude sulfate is boiled with soda ash to convert the radium, barium, calcium, etc., to the form of carbonates. The digested residue



Mme. Curie inspecting the plant of the Standard Chemical Company at Cannonsburg, Pa., escorted by President Gray and Mr. L. F. Vogt, works manager. It was here that the radium was extracted which the women of America presented to Mme. Curie.

is filtered off and washed to remove soluble sulfates, and then dissolved in sulfate-free hydrochloric acid, yielding a solution of radium and barium chloride with calcium, iron, and alkali chlorides. The solution is treated with ammonia to precipitate the iron present and after filtering is ready for further treatment by fractional crystallization to separate the radium from the barium and other basic elements.

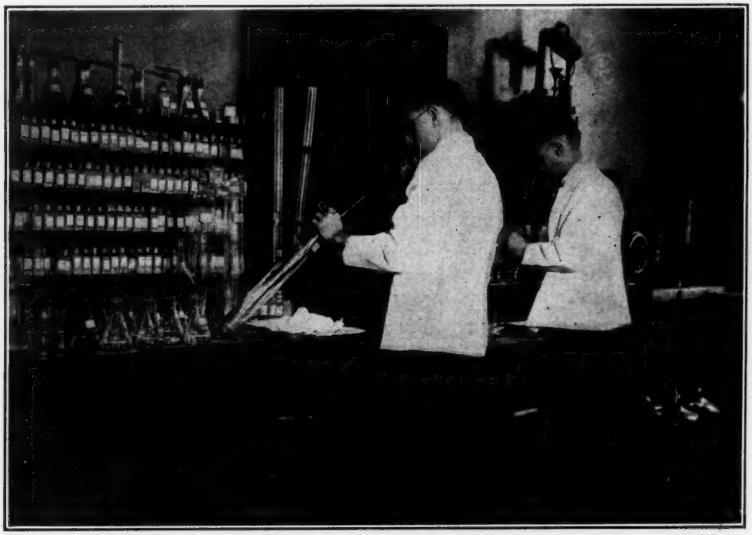
Since the amount of concentrate which will yield a gram of radium

amounts to from 125 to 150 tons, and consists of a press cake which disintegrates to a very fine powder, and since it is essential to treat this entire mass with hot, *concentrated* hydrochloric acid—a very large amount of acid must be used, 250 to 300 tons being needed for the amount of concentrate mentioned. In addition, sulfuric acid, soda ash, caustic soda, and ammonia are required, making the total tonnage of chemicals used in producing a gram of radium aggregate 450 to 500 tons, with approximately 10,000 tons of treated sulfate-free or distilled water, and 1000 tons of coal to supply the solutions and necessary heat. The work requires 300 men constantly to produce one gram of radium per month.

Since radium so closely resembles barium in its chemical properties it has not been found possible to separate these two elements by a chemical process. Madame Curie in her classical work which led to the first production of radium salt of high purity, found that a fractional crystallization of the radium barium chloride resulted in a slight separation of these two elements. By preparing a boiling saturated aqueous solution of the radiferous barium chloride, it was found that on cooling such a solution to room temperature, about half of the barium chloride was precipitated as crystals, carrying about three-fourths of the radium present; the mother liquor containing the remaining half of the barium chloride and one-fourth of the radium. The chlorides of calcium and alkali metals present in the chloride liquor concentrate with the barium in the mother liquor and require no special treatment for their removal. Lead, however, tends to stay with the radium and must be removed by special treatment as indicated further on.

Systematic application of the fractional crystallization through six to nine stages, results in the production of a head fraction, containing approximately 80 per cent of the radium with 20 per cent of the barium present in the initial salt, a second fraction with 15 per cent of the radium and 20 per cent of the barium, leaving it therefore sensibly the same as the starting material, a third fraction containing 25 per cent of the barium and 4 per cent of radium, and a fourth fraction, or tail, with 35 per cent of the barium and about 1 per cent of the radium. Accumulated tail fractions may be worked up to yield a head that will be added to the accumulated third fraction, and from this a head is obtained which is added to new chloride liquor and the second fractions for a regular crystallization. The head or first fractions from several such series are combined to make the start of a second or "intermediate chloride" series and the heads from this form the starting point for a "high chloride" fractional crystallization. The heads from several such "high chlorides" are treated in solution with hydrogen sulfide to remove the lead which tends to go with the radium, the lead sulfide is filtered off and the radium and barium in the solution are then precipitated as carbonates, washed and dissolved in hydrobromic acid to form

the starting point of a "low bromide" crystallization. The advantage of the bromides lies in the fact that in the deposit of half of the barium bromide in crystals, there is about 90 per cent of the radium separating as compared with 75 per cent of the radium separating with half of the barium chloride. The heads of the "low bromide" series form the start for a "high bromide" fractional crystallization that finally yields head fractions consisting of practically pure bromide of radium, over 90 per cent of the radium started within the "high bromide" series being present in this head

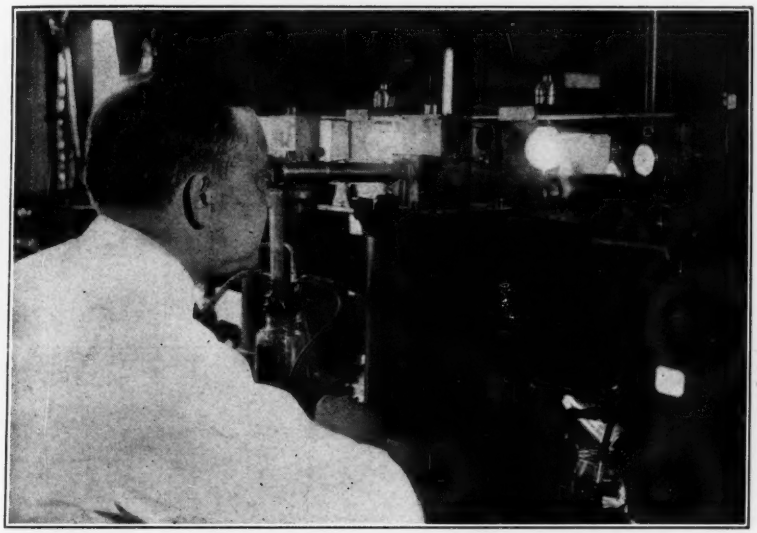


Chemical preparation of samples for determination of radium content by the "emanation" method. Two hundred-millionths of a gram of radium constitute the amount desirable in an analytical sample.

fraction. At the outset about 1000 pounds of barium chloride are associated with a gram of radium in the chloride liquor obtained by purifying the crude radium barium sulfate. At the state of converting the chloride into bromide the radium concentration has increased so that a gram is associated with about 20 pounds of barium bromide and in the final product, a gram of radium in the form of pure anhydrous radium bromide, $RaBr_2$, weighs 1.71 grams.

In the earlier stages of fractional crystallization the greater mass of material to be handled makes each operation slower, the first fractionations being made in large enameled vessels, with 1000 to 1500 liters' capacity, and heated by steam coils. The intermediate fractionations are carried

out in large porcelain or vitrosil bowls, heated directly over gas flames and supported on iron tables. The final stages are carried out in smaller porcelain dishes and transparent silica beakers, using tall narrow beakers to keep the operator's fingers as far as possible from the active material. Having established the necessary fractions for all the series of crystallizations, the material taken in at the initial fractionation passes through the series with only the trifling mechanical loss involved and that due to radium discarded in the low tail fraction. The combined crystallizing

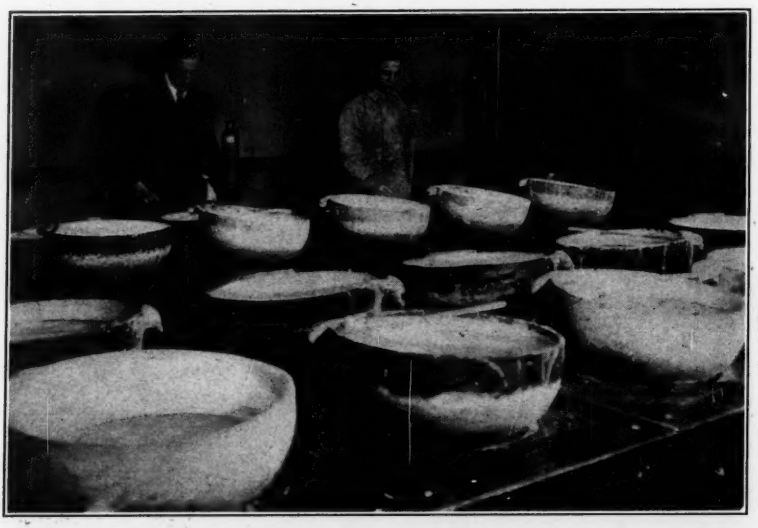


Electroscopic determination of radium in a mill process sample, by the "emanation" method.

losses need not exceed one-half to one per cent, and the complete operation of all the successive series requires seven to eight weeks' work.

The mining, concentration, chemical treatment, and fractional crystallization to pure radium salt require, on the average, for a given gram lot of radium, a total minimum time of six months.

There is no danger from the radio-active effects of radium until it has been concentrated to the stage of crystallization, and in this work it is most essential to ventilate and remove the gaseous radium emanation, which is evolved from the solution in process of fractionation. In the last stages of the bromide fractionation, the action of rays from the radium decay products (RaB and RaC emit the beta and gamma rays, which because of their penetration are able to act on tissues) is to be avoided, and this is



Early stage in the fractional crystallization of radium barium chloride.

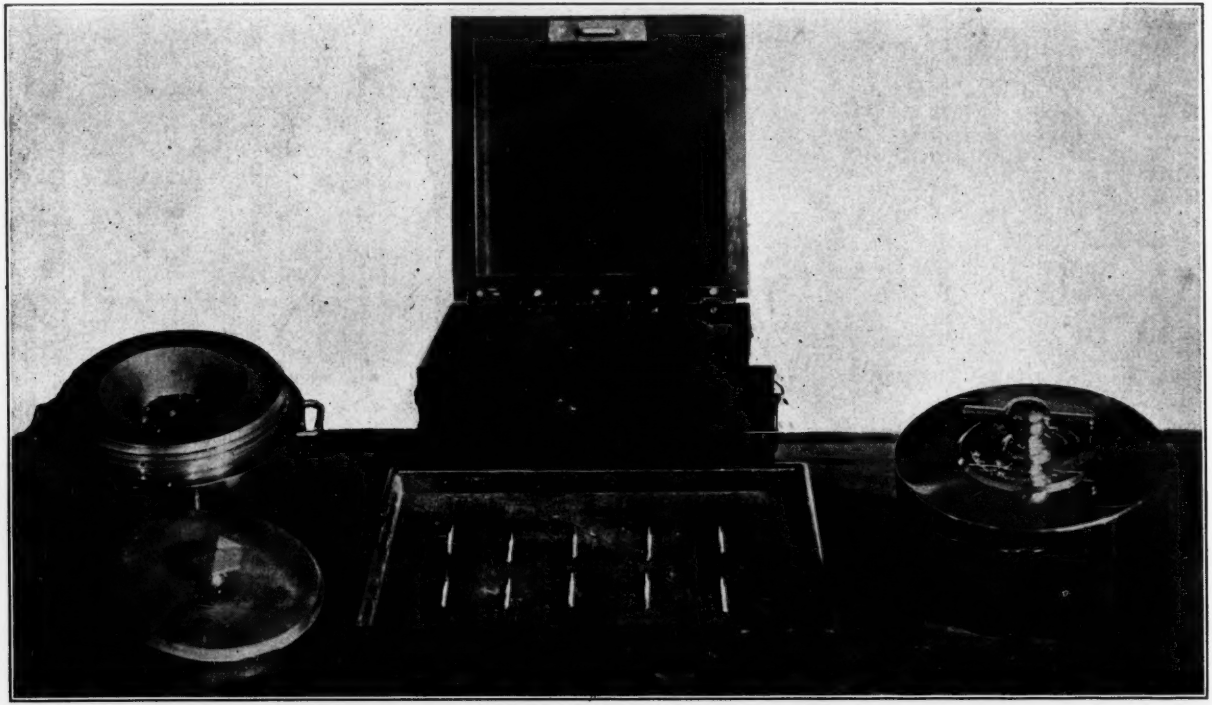
Final stage in the crystallization of Mme. Curie's gram of radium. The silica dish shown contains over two grams of radium in the form of radium barium bromide. This represents all the radium from a thousand tons of milling carnotite ore.

accomplished in two ways: First, by keeping a fair distance from the active preparation, and second, by de-emanating the preparation by heating, which results after three hours in the fairly complete decay of the RaB and RaC, and the preparation largely losing its beta- and gamma-ray activity. When thus deactivated, a gram of radium is no more active than 25 to 50 milligrams of "aged" radium, and the material can then be handled with comparatively little danger to the operator.

The largest use of radium has been found in the treatment of disease.

Tubing radium. Protected by thick lead plates, the powdery white bromide of radium is carefully transferred from a tiny dish to the thin-walled glass capsules shown in the next illustration.

The very penetrating gamma-rays, electromagnetic waves analogous to the X-rays, but of shorter wave-length, act selectively to destroy certain types of tissue cells, and among these sensitive tissues are some forms of cancer and other tumors. For such medical use the radium is placed in small tubes containing 25, 50, or 100 milligrams of radium element, usually in the form of a fairly pure radium sulfate preparation. Other applicators, called needles, consist of a suitable pointed metal shaft, in which the radium is enclosed. These are inserted directly into tumor masses and when the action of the radiations is deemed sufficient, the needles are withdrawn by means of a wire or thread passed through an eye opening at the blunt end of the needle. Plaques with the radium salt distributed over a surface,



Mme. Curie's gram of radium, with container and case. Each of the ten glass tubes contains a tenth of a gram of radium in the form of pure radium bromide. The combined weight of container and case is 112 pounds.

were formerly made by mixing the radium with a varnish which was spread thinly over a suitable metal plate. Due to the ozonizing action of the rays, the organic material soon became brittle and such radium plaques were short lived. At present the most durable plaques are made by fusing the radium in the form of an enamel (low-grade radium silicate) on a suitable metal back, or by spreading a thin layer of radium salt in a tray-like holder, with a very thin metal sheet covering the radium salt and holding it in place.

The amount of radium used in the treatment of disease varies widely with the different conditions treated, but it may be said that for many conditions, an amount of 50 milligrams suffices. Where many patients are being treated, much larger quantities of radium are used. Since the radium preparations are not striking in appearance, particularly when encased in metal screens and attached to growths with the necessary dressings, it not infrequently happens that with the removal of such dressings the radium is not removed, and as a result passes to the incinerator with the dressings, before the omission is noticed. To avoid the possibility of loss of radium among those using it on a large scale, a method has been devised whereby the radium itself is not applied to the disease, but only the radium decay product, radon, or radium emanation.

Radium loses each day by transmutation into radon about one millionth of its mass, so that from a gram of radium, each day, there is produced a microgram of radon. This is an inert gas and by suitable means, can be quantitatively removed from a solution of a soluble radium salt, such as radium chloride. By decay, the radon rapidly produces RaB and RaC, which are the radio-elements giving rise to the penetrating beta and gamma rays. Hence, when a radon tube is applied to a growth, the same rays come into play that come from a radium preparation. But radon loses 50 per cent of its activity, due to its atomic decay, in 3.85 days, half of the remaining activity being lost in the next 3.85 days, and only one-half per cent of the initial radon and activity remain after 30 days. The daily yield of radon from one gram of radium has an initial activity equal to 164 milligrams of radium (164 millicuries), and of this, 150 millicuries can readily be recovered for use. As radon sells for $1.50 to $3.00 per millicurie, and as one millionth of a gram of this substance equals 164 millicuries, it is probably the most expensive substance sold, when considered from a weight basis. It is only the fact of radon's more rapid radio-active transformation that permits its use in the treatment of disease at costs that are much less than those of an amount of radium having the same activity. It must be recalled, however, that while a radon preparation will in general serve only for the treatment of a single patient, radium of the same initial activity will serve indefinitely for the treatment of many, since the rate of decay of radium is about 1 per cent in 25 years, or half in 1700 years.

The greatest industrial use for radium and practically the only important use, aside from its medical application, is in the radium luminous paint. When the alpha rays (helium atoms) impinge on certain substances, notably special forms of phosphorescent zinc sulfide, scintillations are observed, and if the radium salt in sufficient amount is incorporated in such radio-sensitive zinc sulfide, a powder is produced which, by reason of the great number of separate light flashes, emits a continuous glow. The phosphorescence of the zinc sulfide is temporarily stimulated by exposure to light but with the radio-active zinc sulfide, after keeping it in darkness long enough to allow complete decay of all phosphorescence, there still remains the luminescence due to the action of the rays. Ordinarily about 10 to 25 parts of radium per million suffice to give the necessary glow, which continues effective for a period of 7 to 15 years. There is a gradual discoloration of the zinc sulfide under the action of the rays, and as this coloration deepens, the luminosity of the material diminishes. It has been found that a short heating of such discolored radium-luminous material to dull redness, discharges the color and the initial radio-luminescence and phosphorescence are restored.

In use, the luminous compound is applied by mixing the powder, which is a fine granular crystalline material, with a suitable transparent adhesive, which is chosen with respect to its ability to resist discoloration under the influence of the rays, as well as with regard to the surface to which it is applied. On paper, for example, a clear thick gum arabic mucilage makes an admirable "water soluble" adhesive. For metal and porcelain, varnishes of the mastic and damar types are useful, although these discolor more readily than does the gum arabic. Celluloid finds more use on lacquered surfaces, but has the disadvantage of easily peeling off from bare metal and porcelain surfaces.

The uses of radium-luminous material are essentially those where a small amount of light, observed in complete or nearly complete darkness may prove useful. Its cost precludes the covering of large surfaces and if relatively great brightness is essential, it may be attained only by the use of a large proportion of radium, with greater cost and the disadvantage of more rapid discoloration and loss of luminosity. The typical uses for the material are the illumination of watches and clocks, various types of instrument dials, such as those on airplanes, submarines, automobiles, locomotives, etc., push buttons, electric light pendants, house numbers, and markers to serve as guides when moving about in the dark.

In conclusion, a few words may not be amiss regarding the analytical methods used in the control of radium extraction and in the measurement of quantities of radium when this substance is sold. As long as the ore is untreated chemically, for such a material as carnotite, the approximate equilibrium ratio of 3,000,000 to one for the ratio of uranium to radium

remains constant, and the analytical determination of the uranium gives a factor from which the radium content can be fairly estimated, each per cent of U_3O_8 corresponding to a content of 2.56 milligrams of radium per ton of the ore. After chemical treatment of the ore, the uranium content no longer is an index of the radium content, and the so-called "emanation method" of radium determination is generally employed. This method consists in bringing into complete solution a known weight of the radium-containing material, and after complete removal of all radium emanation, by boiling or otherwise, sealing the solution for a known time interval, after which the accumulated radium emanation is brought suitably into the ionization chamber of an electroscope. Here the amount of emanation is determined by the rate of discharge of the instrument, which has been calibrated by similar observations on the effect of the emanation from a dilute radium solution of known radium content. This method has the advantage of being specific for radium, since only radium produces radium emanation and the method is so delicate that by use of a gram or two of sample, materials can easily be analyzed with an accuracy of one per cent, when the radium content is in the order of one or more milligrams per ton.

After the final purification of radium, and the preparation of the various forms of applicators, it is, of course, impractical to take aliquot parts of the usually used insoluble radium sulfate to make analysis of the radium content by the emanation method. The intensity of the gamma rays from radium B and radium C, in a preparation attains a maximum after the preparation has been hermetically sealed for about five weeks. The exact comparison of the gamma ray discharge rate of an electroscope by such an "aged" preparation of unknown radium content, as compared with the discharge rate under identical conditions, using a standard of known radium content, gives a means of calculating the radium content of the unknown preparation. The experimental error in gamma ray measurement is less than one per cent when the radium standard used is one accurately agreeing with the International Radium Standard prepared by Madame Curie, and now used as the basis of all such gamma ray measurements.

The gamma ray method of measurement as generally performed does not differentiate between penetrating gamma rays from the radium decay products and those, for example, due to thorium decay products. So that the purchaser of radium, even though the gamma ray measurement of the preparation has been certified by the National Bureau of Standards, is dependent upon the statement of the seller as to the exact nature of the radioactive constituents of the preparation. Subsequent gamma ray measurements made one and two years later, will show whether the preparation contains any considerable amount of radium substitute, since, if pure, the activity will show no change within the limit of the error of measurement;

whereas, if any considerable quantity of mesothorium (the only important radium substitute) is present, due to its constantly changing gamma ray activity, appreciable changes in the gamma ray activity of the preparation would be noted.

Fundamental Data on Science Gathered in New Volumes. The fundamental facts and figures upon which physical science is built have been brought together and issued for the use of the world in International Critical Tables, the first volume of which has just been issued by the National Research Council and the National Academy of Sciences.

Millions of experiments extending over years of time in the various laboratories of the world were necessary to produce the hundreds of pages of explanations and statistics that will be included in the five volumes of the completed work which are being compiled by the editors with the aid of specialists and experts here and abroad.

The first volume just off the press contains among other valuable information the accumulated data on no less than 9534 different chemical compounds, the new and old facts on radio-activity and transmutation, astronomical and geodetic data, and a comprehensive discussion of the most recent developments in the field of atomic structure, favorite speculative playground of physicists of the present moment.

Along with the international metric system and a listing of the seventy-four countries in which it is now compulsory are the local systems of weights and measures in use in twenty-five still conservative countries. The measures used by the Pharoahs of Egypt and the ancient Chaldeans may likewise be found side by side with their modern equivalents in feet and meters, gallons and liters.

Thousands of dollars and many hours of time will be saved the research workers of the present and the future by the use of this collection of necessary and essential data on a wide variety of allied subjects in one set of volumes.—*Science Service*

New Kind of Light Supplied by Chemistry. "Chemiluminescence" is the term applied to a new kind of light caused by chemical reactions which involve no burning or combustion. The practical application of this principle, according to advices received here, has been worked out in a factory in Hungary where a tube has been devised in which chemiluminescent reactions can be carried out in a vacuum.

The materials which have thus far proved most successful in this capacity are chlorine gas and sodium vapor. These two elements brought together in this form combine to produce sodium chloride, or common table salt, giving off in the process a brilliant yellow light. About one-tenth of the energy involved in this reaction is converted into light.

It is expected that such tubes will find practical use for special scientific experiments and among surgeons, due to the fact that the light they give off is of only one color and not composed like ordinary daylight of all the colors of the spectrum.

An idea following somewhat similar lines has been devised in this country for making luminous compounds. According to a patent recently granted, the phenomenon of phosphorescence can be produced by the reactions of two classes of substances known as "luminophores" and "phosphorogens" with a base of some mineral carbonate and a combustible material like starch or sulfur. Luminophores are compounds of the lighter metals such as sodium and potassium, while the phosphorogens are compounds of heavier metals like silver, nickel, and the radio-active uranium and thorium. These latter make the limestone base phorphoresce and the former impart the desired color to the glow.—*Science Service*

THE VALUE OF ORAL EXAMINATIONS*

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Perhaps one of the most discouraging difficulties with which the professors of chemistry in the high schools and colleges have to contend is the large amount of matter they are obliged to cover in the period of the school year. Much against their better judgment they are compelled to hurry along to meet the demands, touching lightly the subjects they realize should be stressed, and making costly sacrifices in their endeavors to live up to the expectations of the school or college board. As a result of these hurried skirmishes over a field which is an exact science, some of the serious students receive the impression that chemistry is a subject to be slighted, while others, only too eager for an excuse, deliberately manufacture this false notion.

To cope with this existing, undesired condition many teachers resort to frequent written examinations, holding tests every week or two weeks with a measurable amount of success. This course, however, exposes the student to the danger of forming that all too-prevalent habit of cheating, if the teacher does not strictly prefect his examinations, with the logical result that the intended end is defeated, the student's intellect pauperized and his character weakened. Every teacher realizes that in written examinations it is difficult to preclude cheating, even though the utmost precautions are taken. To ignore serenely its existence or to assert it can easily be frustrated is, to say the least, foolhardy.

Unquestionably, written examinations are blessed with advantages of no mean importance. For example, every professor will openly admit that a student, if he can clearly, definitely, and correctly state in writing the answer to a question, undoubtedly understands the point at issue, providing the question is one requiring real thought on his behalf, and is not one that may be answered by the aid of a brilliant memory. Parrot-fashion answers echoing the voice of the author are only a test of a good memory, the development of which is not the real aim of chemistry. The more important end of chemistry is rather the development of the powers of observation and reason. We should strive always to keep these factors before the student's mind and discourage him from regarding it as a memory course. This may be accomplished by asking questions where plain memory will be of no avail. Then if the student exhibits real knowledge, we may reasonably feel satisfied. But, from our experience, we must confess there are very few papers in an examination with which we are perfectly satisfied, and which stimulate our confidence in the student's grasp of the subject-matter. A great many of the papers are poorly written, and some of the simplest ideas are so distorted and badly

* Paper read before the Washington Association of Chemistry Teachers, November 20, 1925.

mutilated that they resolve themselves into just so many puzzles. Is it, after all, such an amazing fact that the student's opinion of chemistry is unprintable, or that he should be harboring such a horror of the science, if he really believes what he has written? Indeed it would be a well-nigh hopeless task for even our most illustrious chemists to master such a heterogeneous mass of absurdities.

These warped views are possibly due to faulty explanations on the part of the professor, but more likely they are the fruits of inattention and lack of study, because no teacher could be guilty of promulgating such glaring errors. These deranged impressions may be the result of extreme nervousness, but more often they are the products of the bluffer who is using the hit-and-miss method, with the last fond hope that some of it will be right, rather than admit his ignorance by leaving a blank space. That these mistakes are blind stabs or wild guesses is demonstrated by the fact that the offender, when called upon to explain or interpret the terms and the meaning of his answer, is at an absolute loss as to its meaning, and his translation instead of clarifying the air befogs it all the more.

One of the strongest arguments in favor of the written tests is that of convenience. True, it requires far less exertion, patience, and time than would be necessary for an oral quiz, but these apparent virtues are in themselves its own self-accusation and condemnation. On account of the very limited amount of time allowed for the written test very few questions may be asked, and as a result a very meager picture of the student's knowledge is obtained. In contrast to this we have for our inspection the broad view offered to us by the oral quiz, which is characterized by a large number and variety of questions. Of course, written examinations are as fair for one as for the other, but a student who may get only fifty per cent on ten questions asked in a written would perhaps get a higher per cent in an oral, where more ground would be covered. While on the other hand, a student fortunate enough to study only the questions asked in a written would not do as well in an oral test. The mark given the first student does not mean that he knows only one-half of the matter covered during the month but that he knew only fifty per cent of the limited few questions asked in the written test. So that at times we undoubtedly are misled into believing good or bad about a student by a percentage obtained from these curtailed examinations.

A glaring fault which seems quite prevalent among the students is their utter lack of logical procedure in the solution of their chemical difficulties. Testimony of this is extended to us in almost every examination. Often, from the caliber of the answer given, you are able to discern that the student has really a better knowledge of the subject at hand than is demonstrated on the paper. Frequently, no doubt, you feel confident that were you free to suggest a few related questions leading up to the main one, the student

could express his knowledge more clearly and convincingly. You realize very acutely at that moment the need of personal direction in these cases, while at the same time the utter hopelessness of accomplishing this with any telling effect flashes before you. This splendid opportunity, which is lacking in the written tests, is afforded you in the orals, where, by the logical sequence of your questions, you may draw forth from the student knowledge he would never divulge in a written examination. And while the iron is hot, you could strike with telling force indicating to the student the method he should adopt in attacking the particular subject and how he should reason out the difficulties he encounters.

One very grave disadvantage connected with written tests, one which is most unfair to the students, and which on account of the limited amount of time at the teacher's disposal cannot be very well offset, is the fact that very often there is no public review of the mistakes made by the students. Granted a public review is made, usually it comes so late that the students have forgotten much of what they had written. Furthermore, the type of students most guilty of the blunders care little now about corrections and will pay little, if any, attention to your endeavors to right their erroneous beliefs. Consequently, the corrections become bereft of all the force they were intended to carry.

Another serious error accompanying the written tests is the looseness in the use of chemical terms. How often have we received papers wherein was practised the indiscriminate use of very common terms, such as ion for atom, atom for molecule, solute for solvent, theory for law? It is surprising the number of students that have such mangled interpretations of the terms "theory" and "law." Many identify the one with the other using them as though they were synonymous terms. In the oral tests which force the student to think accurately and correctly while on his feet, such blunders as these will be reduced to a minimum, because the student knows full well that every slip will be called to his attention and that he will be compelled to retract all false statements and the abuse of scientific terms.

Perhaps the only kind of an examination that offers a safeguard against these disadvantages attending a written examination is the oral quiz, providing it is properly conducted. Our main purpose in holding orals should be to compel the student to study assiduously and to understand the matter, and to lend him the personal assistance necessary to overcome the wrong impressions he may be entertaining. The secondary and less important end may be to determine the standing of the student in the class. The personal oral quiz is the most powerful weapon we may use to accomplish this end. Every student realizes that he is obliged to face that trial and the only sure way to make a favorable impression is to know the matter thoroughly, which requires honest, arduous work on his part because it is impossible to cheat.

The students may be listed according to their class standing. The brightest should be selected to appear first, having been given ten days' notice to prepare the material, while the less bright, of course, receive a longer period in which to prepare the subject-matter. It may be objected that the slower students have the opportunity of profiting by the experience of the brighter ones, who would act as informers distributing valuable information as to the method of questioning and the difficulties met. This is just what is desired. The more the brighter students help the slower ones the more pleased we should be. The slower students are deliberately selected to appear late to allow them sufficient time to master the subject-matter.

The meeting should be by no means a one-sided affair. The student's assistance should be enlisted in solving his own difficulties, and no student should leave the room until all is clearly understood. That extreme patience is required may be testified by the fact that in some of our cases as much as an hour and a half to an hour and three quarters was devoted to both examining the students and correcting their wrong impressions. The meeting should be friendly, strictly informal, and once the student enters the room we should strive to make him at ease so he will be under no handicap.

On account of the length of time consumed in the accomplishment of these tests the occurrence of these orals will be infrequent. But even if they were held only twice a year, the first just before the mid-year examinations, and the second just before the finals, both the students and professors would be richly repaid for their exertions.

These oral quizzes may seem to some rather harsh, but it is our important duty to teach the student with patience and to see that the knowledge imparted is actually received, and should there be any doubt of it, to have recourse to strict measures which will efficaciously accomplish this end. Frankly, I will admit, to say the least, that oral quizzes are extremely tedious and at times very monotonous and require a seemingly endless supply of patience, but the untold benefits derived by the students so greatly outweigh these temporarily entailed discomfitures, that once the orals are inaugurated and given a fair trial their continuance may be safely assured.

Science is trying to encourage the spirit of inquiry, the desire to know, the ability to ask and answer questions for the sake of answers only as they increase interest and ability in answering other questions. Science recognizes that continued evolution of human mind depends upon the continued use of mind in inquiry, in conclusions, in application, in the establishment of new truth. Science accepts Poincare's statement that "Man is the measure of his own universe." Science asserts that negative ethics is inconsequential as compared with positive.—OTIS W. CALDWELL

PAINT AND VARNISH RESEARCH AT THE BUREAU OF STANDARDS*

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The work on paint and varnish at the Bureau of Standards is made necessary by numerous calls from various branches of the Government Service for general or specific information on questions relating to the properties and use of paint and varnish materials. This work is primarily a part of the work of the Chemistry Division, one of the seven sections of this division having such problems assigned to it.

The personnel available for this work consists of eight men of professional grade and one of sub-professional grade. Only one of these men, however, has been able to devote his whole time to research work although all devote part time to investigation problems. The reason for this is that the Bureau is called upon to test samples of a very great variety of paint and varnish materials for nearly all branches of the Government Service. This testing work must be done promptly to be of practical use and it therefore must generally take precedence over all other activities of the laboratory.

The equipment in addition to the usual work-benches, hoods, apparatus, and chemicals to be found in any well-equipped chemical laboratory includes much specially adapted to this particular work. For example, a battery of three stone paint mills of laboratory size in which experimental batches of oil paints can be easily prepared in batches as small as one pint; Thompson Classifier used for investigating the fineness of certain pigments;[1] Pfund colorimeter for measuring the color of nearly white surfaces;[2] Keuffel and Esser color analyzer for spectrophotometric analysis of colored materials;[3] Pfund hardness tester; swinging beam tester for measuring the hardness of varnish and similar films;[4] rotating disc apparatus with half white and half black plates for preparing paint and varnish films for measuring various properties including hiding power;[5] Gardner testing machine for determining tensile strength and elongation of paint, varnish, and lacquer films;[6] Ingersoll glarimeter used for measuring the

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[1] *Proc. Am. Soc. Test. Mtls.*, **10,** 601 (1910).

[2] *J. Frank. Inst.*, Mar., **1920,** 371.

[3] For description apply to Keuffel and Esser Co.

[4] The Pfund tester is described in *Proc. Am. Soc. Test. Mtls.*, **25,** 392 (1925). The swinging beam is described in Cir. 229 of the Scientific Section, Paint Manufacturers' Assn. of the U. S.

[5] The apparatus without the half white and half black disc is described in *Proc. Am. Soc. Test. Mtls.*, **22,** Part 2, 464 (1922). The use of the half white and half black disc for hiding power determination is described in *Technologic Paper* No. 306 of the Bureau of Standards.

[6] Cir. 240, Scientific Section, Paint Manufacturers' Assn. of the U. S.

gloss of painted surfaces; iron arc and quartz tube mercury arc lamps for studying the effect of ultra-violet light on pigments, paint, varnish, etc., and racks for weather exposure tests covering a large area of the roof. The above is only a partial list of the special equipment of the paint and varnish laboratory and numerous other pieces of special apparatus are on hand. In addition, the exceptionally complete equipment of other branches of the Bureau in optical and other physical instruments is avail-

View in paint laboratory, B. of S. *A*—Apparatus for determining hiding power of paint. *B*—Machine for testing strength and elongation of paint, varnish, and lacquer films. *C*—Penetrometer for studying consistency of paste paints. *D*—Glarimeter for measuring gloss of white paints.

able. A considerable number of useful pieces of apparatus have been devised in the paint and varnish laboratory, for example, the rotating disc apparatus and the swinging beam tester. Others have been developed in other branches of the Bureau, as, for example, the Keuffel and Esser color analyzer which was developed in the Optical Division.

The large staff of physicists, chemists, and engineers specializing in many fields of science and engineering afford most unusual opportunity for consultation with experts who, while specializing in other lines frequently can offer most valuable suggestions.

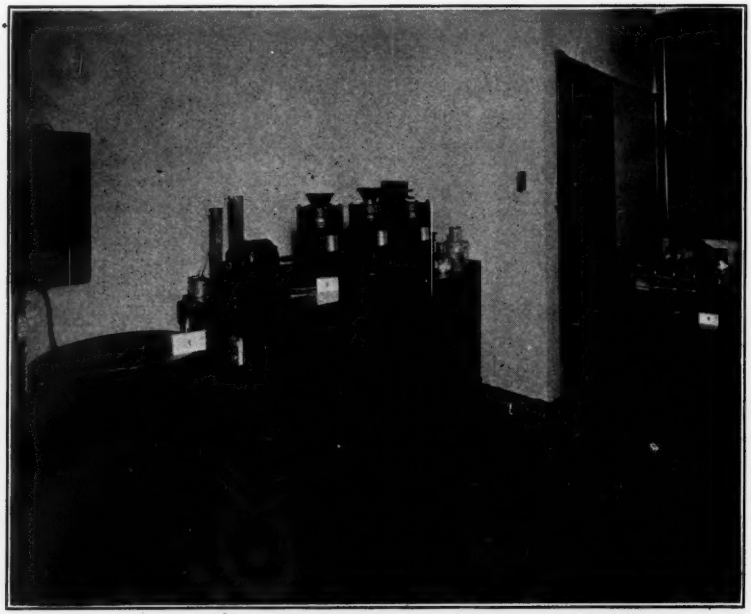
Brief mention has already been made of the testing work, but it is well to point out that this testing work has not been a by-product of investigations carried on in the Bureau but has on the contrary made necessary most of the investigations. A few years ago almost all samples received were sent for examination to learn if certain composition requirements or guarantees were met. In many cases at that time the available published methods of analysis were inadequate or unreliable. The greater

View in paint laboratory, B. of S. *E*—Apparatus for determining specific gravity of pigments. *F*—Apparatus for determining water in paint.

part of the time and energy available for research work was, and still is, of necessity, devoted to the study, improvement, and devising of methods of analysis and test. It is apparent that in order to test any material for any particular purpose and to render a report that will be of value to the non-technical purchaser and at the same time be entirely fair to the producer some form of specification, either accurately defined or at least implied, is necessary.

Paint and varnish specifications were of the most varied character and in many cases were worthless as guides to differentiating between satisfactory and unsatisfactory material. The laboratory had constant calls for suggestions regarding specifications, but until the period of the

great war it was impossible to get any coöperation between the different users in the Government Service. Hence there were many specifications for the same type of material that differed from one another to a greater or less extent. In many cases these differences were entirely immaterial from any practical consideration as to quality but nevertheless were of such a nature that a material would be accepted by one branch of the Service and rejected by another, even when reported in exactly the same



View in paint laboratory, B. of S. *G*—Battery of stone mills for grinding small lots of paint. *H*—Roller mill for grinding small lots of paint. *I*—Centrifuge for separation of pigment from paint.

form and intended for exactly the same purpose. During the war the War Industries Board made a beginning in efforts to have the different Departments adopt the same specifications for the same paint and varnish materials and shortly after the Armistice an Interdepartmental Committee on Paint Specification Standardization under the chairmanship of a representative of the Paint and Varnish Laboratory of the Bureau of Standards made considerable progress in this direction. This work has been further advanced since the formation of the Federal Specifications Board.

The preparation of an adequate specification involves research along the following lines:

(1) Acquiring information by service and laboratory tests of the suitability of material for the given purpose. This must be supplemented by field inspections of work done with the materials as well as collecting information from other persons or organizations making similar tests and inspections.

(2) Consideration of relative cost and availability of materials found suitable for the purpose.

(3) Development of method of sampling and testing that will be sufficiently reliable and accurate to insure determining grounds for rejection of unsuitable material and at the same time not run the risk of rejecting satisfactory material.

While all of these three general subjects are of major importance, the time and energy consumed under the third and first headings is much greater than under the second. The greatest amount of work is done under the third item. In the problem of analysis of pigments, complications are constantly arising and the laboratory is continually learning of hitherto unsuspected limitations of the methods and is constantly working to improve existing methods and devise new analytical procedures applicable to the various mixtures in paint pigments.

Of more importance than the analytical work is the study of methods of physical testing, but the progress is very much slower. If we had accurate and reproducible methods of defining and determining the physical properties of paints both in the can and during the process of application and drying; and had physical methods of testing the dried film that would give information as to the durability, there would be no reason from the standpoint of the consumer for doing any chemical work. Chemical analysis will always be of great value to the manufacturer, who must use it to control manufacturing operations and as an aid in duplicating a rival's product; but the consumer is primarily interested in the physical properties of the material as he buys or uses it. If he could ascertain all of the desirable and undesirable properties of the finished material he should be no more concerned with the composition of the paint than a man purchasing a saw would be concerned with the ore, coke, and flux used in producing the steel. Unfortunately, we know so very little about the desired physical properties and practically nothing of tests that give indication of life of paints that we are compelled to form our opinions by applying the knowledge gained from observation of the service of paints made from certain materials. Hence we must use analysis, as illogical as it is, because we lack anything better or even as good.

All paint and varnish technologists will remember that only a few years ago there was practically a universal opinion among thoughtful users of oil varnish that good varnish could only be produced from certain high-priced raw materials. Much time and effort were expended in our

laboratory in the study of methods of analysis, and while the methods developed and published here were probably the best devised up to that time, and are even now as good as any published methods, they are entirely inadequate for determining the actual composition of the non-volatile portion. We were fortunate, however, in our study of oil varnish in establishing most cordial relations with some of the most able investigators in the industry and in the fact that certain very simple physical tests give considerable information regarding the durability of oil varnishes. It was with very serious doubt that we first decided, about eight years ago, to practically abandon all attempts to specify composition of oil varnish and to recommend a specification based on the simple physical tests. The results have been most gratifying. At once material of better quality was obtained at a very much reduced price. It is noteworthy that one large department of the Government reported an estimated saving of $90,000 through the use of this specification.

Coöperation

The Bureau maintains close and cordial relations with the Research Laboratory of the Paint and Varnish Manufacturers' Association and not only have several publications recording investigations carried out by our staff appeared as circulars from that organization, but on several occasions research associates from that laboratory have worked for considerable periods in our laboratories and have issued valuable publications resulting from such work. There is hardly any activity of Committee D-1, on Protective Coatings for Structural Materials, of the American Society for Testing Materials, that is not being actively supported by work at the Bureau of Standards, and the numerous standard and tentative standard specifications for paint and varnish materials and methods of test have in practically all cases been largely based upon our work and in a large number of cases have been mainly worked out at this Bureau.

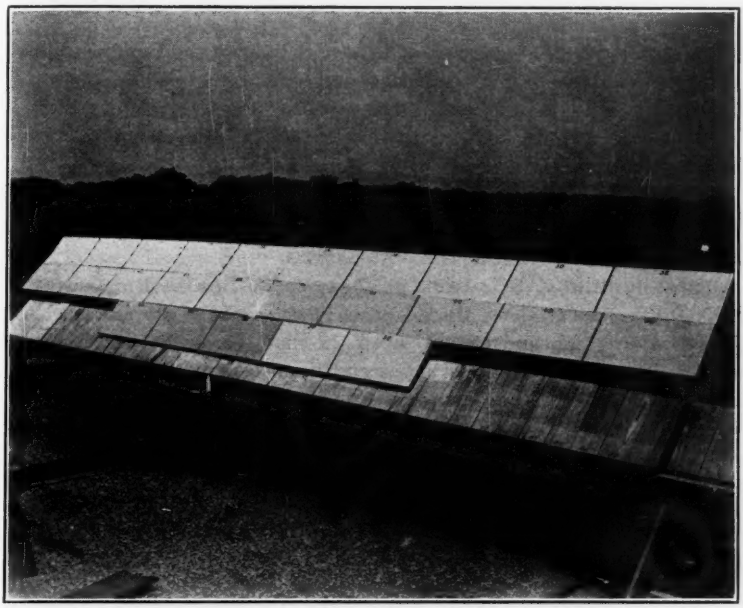
It is a natural question to ask how this Government laboratory serves individual manufacturers and the general public. Hence a statement as to just what we can and cannot do for such may be of interest.

The things the Bureau is prepared to do for private parties:

We try to answer both by publication and by correspondence a great variety of questions on the subject of paint and varnish. Chemists and technologists can visit our laboratory and familiarize themselves with all the details of the methods used.

Arrangements can be made, preferably with associations of manufacturers, for research associates to work at the Bureau on problems of general interest to the industry but not on problems for the exclusive use of any

individual or manufacturer. The qualifications of a research associate and the specific problem upon which he works must be approved by the Bureau. He is given the privileges and is expected to obey the same regulations and be subject to the same supervision as regular employees of the Bureau. The Bureau reserves the right to publish and make any other use at any time of the results of his investigations. His investigation is not to be the basis of patents. A research associate is provided with



Exposure rack on roof of Chemistry Building, B. of S., showing above test panels in early stages of exposure, and below (vertical) panels that have failed.

laboratory space, and ordinary equipment and supplies, but his salary and special equipment and supplies are furnished by the organization coöperating with the Bureau.

The things the Bureau does not do for private parties:

We do not investigate proprietary materials nor make tests or analyses of samples of paint and varnish materials for manufacturers or individuals. We do not authorize the use of tests or of unpublished investigations for advertising or sales promotion, whether such tests have been made for other branches of the Government, for our own information, or in the very rare cases when for exceptional reasons we do the work for private parties.

Among the present activities of this laboratory, some of which have been mentioned above, are:

Preparation and revision of specifications,

Study of miscellaneous analytical methods,

Weather exposure tests,

Accelerated tests intended to simulate weathering,

Study of methods of measuring consistency of paste and liquid paints,

Study of methods of measuring hardness of paint and varnish surfaces,

Study of methods of determining hiding power of paint,

Study of methods of measuring thickness of pain tand varnish films,

Study of methods of preparing paint and varnish that can be separated from the underlying surface and determination of the strength, elongation, toughness, etc., of such films and change in such properties under varying conditions of aging,

Study of the properties of both clear and pigmented nitrocellulose lacquers.

Publications

Official Bureau of Standards publications in this field include ten Technologic Papers, one Miscellaneous Publication, two Circulars of general information and twenty-seven Circulars giving Standard Specifications for a wide variety of paint and varnish materials. The Specification Circulars contain complete directions for sampling and testing. In addition to the official publications a number of papers have been contributed to various journals. A list of these publications will be furnished on application to the Bureau.

Diphtheria Deaths May Be Negligible by 1930. Preventive medicine has scored a real triumph over diphtheria. A survey of the mortality statistics of this once deadly disease reported to the American Medical Association shows that in 1910–14 only thirteen cities averaged death rates under 10 per 100,000; in 1915–19 only eighteen cities could be so classed; but in 1924 there were thirty-seven and in 1925 forty-nine with diphtheria death rates lower than had ever been known before 1910.

There is little doubt, medical authorities say, that this amazing reduction can be attributed largely to the increasing practice of immunizing school children with toxin-antitoxin mixtures or with antitoxin. This opinion seems to be borne out not only by observation in single cities like New York where this method has been extensively used, but by the rapid decline in diphtheria mortality throughout the country.

Antitoxin, as a curative agent, is due considerable credit but the fact that the death rate has dropped so decisively since the immunization measures have been applied indicates that it is the main factor. According to editorial comment in the *Journal of the American Medical Association*, diphtheria may be an almost negligible factor in the mortality returns of 1930, if the improvement of the last three years continues.—*Science Service*

FORECASTING FROM APTITUDE EXAMINATION SCORES

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The Iowa Placement Examination, series CA1, was given to ninety-one of the ninety-eight students who registered for Chemistry 1 at the University of New Mexico, at the opening of the first semester of the 1925–26 college year.

The class in Chemistry 1 was composed largely of graduates of New Mexico high schools. Students who had, and those who had not, taken chemistry in high school were registered in this class. Laboratory sections were arranged according to the free hours of the student schedules.

In this placement examination 62 constituted a perfect score. The scores made by the students examined ranged from $52^2/_3$ down to $23^2/_3$. This range of 29 was divided into ten deciles and each student placed in the decile to which his score belonged.

No student whose aptitude score fell in the lowest three deciles completed the course. Sickness, difficulties over funds, too heavy schedules, etc., were reasons assigned for non-completion of the course. One student was dismissed from college because of poor academic standing. It is significant that these troubles fell increasingly heavily upon students as they were listed in descending deciles as follows:

TABLE I

STUDENTS WHO DROPPED OUT OF THE COURSE FOR ANY REASON WHATSOEVER

10th Decile	10% of those in Decile
9th Decile	13% of those in Decile
8th Decile	13% of those in Decile
7th Decile	25% of those in Decile
6th Decile	50% of those in Decile
5th Decile	70% of those in Decile
4th Decile	$33^1/_3$% of those in Decile
3rd Decile	100% of those in Decile
2nd Decile	100% of those in Decile
1st Decile	100% of those in Decile

At the end of the semester, the ninety-eight students who had registered for Chemistry 1 could be classified as follows:

TABLE II

Withdrawn from college	16
Permitted by Deans to drop Chemistry 1 without penalty	9
Passed the course with a grade of A	3
Passed the course with a grade of B	14
Passed the course with a grade of C	23
Passed the course with a grade of D	18
Received the mark of I (Incomplete)	3
Conditioned	1
Failed	11
TOTAL	98

At the close of the semester the grades made by the students who had completed the course were correlated with their aptitude scores. A correlation chart is given, grades being plotted along the vertical, and aptitude scores along the horizontal axis.

Chart

It can be noted that twelve per cent of those finishing the work of the class had scores that corresponded with their aptitude scores, twenty-one per cent did better work than their aptitude scores indicated that they could do (students making low aptitude scores had been warned to be very alert and careful), and that sixty-seven per cent did work of a grade lower than their indicated capacity.

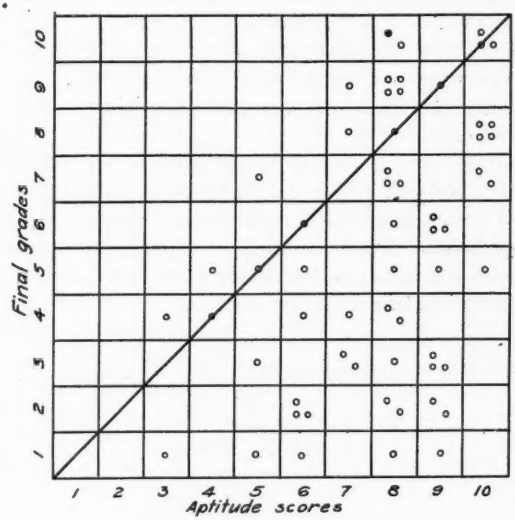

FIG. 1.—Correlation chart.

In these figures can be seen an excellent argument for the sectioning of classes on the basis of ability. Such sectioning is, however, more difficult to put into operation in the smaller colleges than in the larger institutions, due to the limited teaching personnels of the former, and to exigencies of class-hour schedules.

Conclusions

(1) The results of this study indicate that from very low scores made in a standard aptitude examination one can forecast unsuccessful completion of the course with a high degree of accuracy.

(2) The scores made on the aptitude examination predict, with considerable accuracy, the upper limits of student attainment.

(3) There is nothing about the aptitude test which can forecast how much below one's aptitude his final grade may be. We must recognize that extra-curricular activities, lack of interest, or laziness can easily pull the grades of bright students well below their aptitude scores.

SOME UNSTRESSED ESSENTIALS IN TEACHING ELEMENTARY CHEMISTRY*

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That much attention is being given to the teaching of elementary chemistry is evident to anyone who reads the JOURNAL OF CHEMICAL EDUCATION or *School Science and Mathematics*. Never before has there been such an extensive discussion of aims and objectives, organization and content of courses, and methods of presenting material and testing results. It is interesting to note that failures have been assigned to poorly trained teachers, poorly organized courses, and poor laboratory teaching; seldom, however, has any attention been paid to the intolerable teaching conditions which form the foundation for the work in some of our high schools and smaller colleges, conditions which must be radically changed before there can be hope of better results. I realize fully the importance of having a teacher with a real gift for teaching who is endeavoring to follow a well-arranged outline for the presentation of his course; but I insist that such a teacher will fall far short of his goal unless the conditions under which he is working are satisfactory.

Through the kindness of Professor John Guy Fowlkes of the Department of Education of the University of Wisconsin, reports from a number of typical high schools of the state have been made available. These reports contain:

(1) the salaries of chemistry teachers,
(2) the subjects taught,
(3) the number of teaching hours per day,
(4) the length of laboratory periods,
(5) the size of sections in laboratory and recitations.

I wish to discuss these points and show why it seems to me impossible for the teaching of chemistry to be well-handled if they are not properly provided for. Similar information from high schools in other states would be of great interest; there is reason to believe, however, that those schools do not differ materially from the schools of Wisconsin.

Salaries

While many of the smaller schools pay from seventeen to eighteen hundred dollars a year, it is not unusual for the chemistry teachers to receive as low as thirteen or fourteen hundred. Comment on the quality of the resultant teaching is superfluous. A teacher in such a school has but one idea—to get a better job. And this results in a large turnover in personnel, a condition which has received too little attention as a direct cause of poor teaching. With a change of thirty-five to forty-five per cent in the teach-

* An address delivered to the Chemistry Section of the Wisconsin Teachers' Association at Milwaukee, Wisconsin, Nov. 6, 1925.

ing staff is it any wonder that the work suffers? What would we say of a business organization that experienced a similar yearly turnover in its sales or its production division? We would say that it would fail and that it ought to fail!

Subjects

While the chemistry teacher in the larger high schools devotes all his time to this one subject, this condition is exceptional, for, in the smaller schools, he is frequently called upon to teach physics, algebra, and general science. And for some reason or other the chemistry teacher, in addition to his other duties, always seems to coach football and basketball and maybe debating. Whoever arranges such schedules gives little consideration to the fact that the laboratory teacher needs free time in which to prepare materials for his classes and read note-books. Can we legitimately expect a teacher with such a full program to find time for the outside study and reading that will enable him to modify his course and keep it up-to-date? And is it surprising that the work of such a teacher often lacks in inspiration?

Length of Laboratory Periods

Those of us who are university teachers are so accustomed to the recognition of the necessity of long laboratory periods that the discovery of short ones of forty-five and fifty minutes comes as a good deal of a shock. In thirty-six typical high schools the length of time given to laboratory work is as follows:

40–50-minute periods	15 schools
55–60-minute periods	8 schools
90-minute periods	11 schools
120-minute periods	2 schools

Over half the schools have only single periods, which means that there is no consideration given the fact that the chemistry student must take time from his laboratory period to remove his apparatus from the locker and at the end of the hour to clean and replace it. Nor is there any appreciation of the value of starting an experiment and completing it without having to stop and tear down apparatus which must later be reconstructed.

In such a course practice in constructing apparatus will obviously have to be eliminated. Lack of time will also necessitate the omission of all the more complicated experiments such as those involving the use of an analytical balance. The only practical experiments will resolve themselves into those that can be performed in beakers or test tubes. Of course, experience in laboratory technic constitutes a valuable part of the course. The school which so unfortunately limits the length of its laboratory periods makes it impossible for its students to gain this training. One wonders if those responsible for such abbreviated laboratory

periods are consistent to the extent of providing forty-five-minute periods for football practice, including time spent in locker room and showers.

Size of Sections

The number of students assigned to one laboratory section varies from twelve to thirty-three, the smaller sections usually being from small schools where registration in chemistry obviously would be light. That the same evil of large sections in laboratory and class-room exists in colleges and universities is evident from figures compiled by Professor Hendricks in a paper on "How We Teach Freshman Chemistry."[1]

> The most usual-sized quiz group has been thirty and thirty-four students with more than fifty per cent of the colleges having the quiz group that size or larger. A very common comment is, however, that there is need for smaller-sized quiz sections.
>
> The most common size for the laboratory section is between twenty and twenty-nine, though about one-fifth of the institutions have their laboratory sections smaller than twenty students.

Whether twelve or thirty-three should work in one section under one teacher depends entirely on one's conception of what the teacher is supposed to do in the laboratory and what the student is supposed to gain from laboratory work.

If the sole function of the teacher is to preserve discipline and keep the students busy, in other words to act as a kind of foreman or floorwalker, it is possible for one instructor to "look after" thirty-five students. But let us be careful not to confuse this with teaching. The students would learn almost as much by taking the work as a correspondence course. That the laboratory teacher *is* a kind of a floorwalker seems to be the conception of many administrators evidenced by the number of students they crowd into laboratory sections. However, if we are to ask for smaller laboratory classes it is only fair that we should tell why this is necessary.

It is my belief that in the laboratory one teacher cannot properly supervise and teach more than sixteen students of elementary chemistry and these are my reasons.

Laboratory Teaching

The laboratory is the starting place for instruction in chemistry, the class-room is supplementary. The latter deals with a group of students, the former with individuals. The contact in the laboratory is informal, it provides an opportunity for the individual student and teacher to meet mind to mind, a relationship so often lacking. Such individual teaching is more efficient but at the same time it is a heavy drain on the teacher's energy, it is also more time-consuming and more expensive.

However, from my experience as a teacher of chemistry I am convinced

[1] THIS JOURNAL, **2**, 1187–90 (1925).

that the value of laboratory instruction is in proportion to the proper utilization of its peculiar possibilities. It is because I feel very keenly the real contribution such teaching can make to the development of a fusion of thinking and doing, mental and manual dexterity, that I insist it is worth doing well, especially in view of the modern trend of life which gives less and less of such training in the home. It is with this conception as a background that I have organized my own course in elementary chemistry at the University of Wisconsin.

Every fall sees the addition of from nine to twelve new assistants on my staff. Although these men have usually had some teaching experience it has been found best before giving them charge of laboratory and quiz sections to require one year's apprenticeship as laboratory assistants, working under the supervision of one of the older men. Thus they learn our teaching problems and our teaching standards with weekly conferences to supplement their observations. In the first of these conferences we discuss with them the demands we expect to make of them in their laboratory teaching. These demands are covered in the following points.

Attendance

Students are to be in the laboratory at the beginning of the hour and it is the laboratory assistant's duty to record absences and tardiness.

Preliminary Directions

Before the student begins his work a discussion of the principles involved in the experiment is often desirable. Further, the safety of a group of immature students unskilled in the handling of apparatus necessitates almost daily precautions concerning the handling of chemicals. Particular experiments may need special precautions such as the use of the hood in making chlorine or care in the construction of apparatus when making nitric acid.

Answering Questions

For the student who takes his work seriously the laboratory offers an opportunity for clearing up any obscure points encountered in lecture or text-book which may need more individual attention than can be given in the class-room. Then, too, shyness may prevent his asking for help in the presence of the rest of the class. In the problem of overcoming such shyness, which is a common attribute of university freshmen, the chemistry instructor has a decided advantage over his colleague in non-laboratory courses. Unfortunate, indeed, if such opportunity be wasted! And then, there are always questions arising from the particular experiment, questions of theory, or demands for help in such manipulations as the use of the balance, filtration, crystallization, or making titrations.

The problem of "how to answer a question" hardly comes within the

scope of this discussion, but for the benefit of new teachers let me emphasize the fact that this is one of the tests of good teaching. During one laboratory period two instructors were asked for the formula of normal calcium phosphate. The first instructor wrote the formula for the student, the other elicited the information by asking the student to write the formulas of calcium oxide and phosphoric acid, from which he could obtain for himself the valences of the calcium and phosphate ions, and so was able to answer his own question. Comment on the success of these two teachers is hardly necessary, but let us not forget that the latter method took a great deal more time than the former.

Inspection of Apparatus

Certain types of experiments call for inspection of apparatus either from the standpoint of the success of the experiment or the safety of the individual. It often happens that the lower end of a thistle tube in a hydrogen generator is not sealed by the acid in the flask, and every once in a while some one will use a glass rod for a delivery tube in generating oxygen. But there is another reason for inspecting apparatus, one that is not emphasized enough. I believe that the ideal of doing a thing well should be held before the student. In other words, a piece of slovenly apparatus should not be accepted just because it will work. In manual training the construction of a tool box that will hold tools is not enough, the joints must fit and it is usually smoothed and painted. A finished product, something that the student will take pride in, is the result. Admitted that a piece of chemical apparatus is temporary, there is no reason why the same ideal of proper and sightly construction should not be upheld in the laboratory; which means, of course, that tubing must be properly bent and foresight in planning exercised so that match boxes and beakers are not necessary to elevate burners and flasks. Here again such inspection is very time-consuming but worthwhile in adding value to the course.

Correcting Note-books

I am not as much interested in notes containing lengthy descriptions, copied verbatim from the laboratory manual with drawings of apparatus, as I am in a note-book that shows that the student knows how to keep a concise record of his experiments, to separate the important from the unimportant, and to show that he has learned something from what he has been doing. But more particularly I am interested in having the student understand and remember what has gone into the note-book. I am convinced that one of the evils of present laboratory instruction lies in the fact that a more or less mechanically performed experiment is written down and promptly forgotten. An overworked teacher at the end of a week or two returns it with corrections and suggestions which are in-

effective because the student remembers nothing about the experiment and so is no longer interested in it. And the best way to find out whether a student knows what it is all about, and to clarify and fix his ideas, is to question him in the laboratory immediately after completing the experiment, which means that notes should be read as soon as written, and a few pertinent questions asked of the student. Again time-consuming, but decidedly worthwhile.

Quizzing Students

While it is not my intention to make a recitation room of the laboratory, there is a certain type of questioning for which it is suited. The mechanical performance of experiments may be at least partly avoided by pointed questions as to the object of the experiment, the reason for certain procedures, types of apparatus, etc. Further, the interested student will be stimulated through such a process of questioning, he will learn to question himself and so form the habit of really thinking about his work. For if we are to learn from our experiments, life in the laboratory must be one series of interrogations about the problem on which one is working. Here again, the harassed instructor would be unable to launch such a thinking process.

There are, of course, other demands on the instructor's laboratory hours, but those discussed are the most important ones, as we consider them absolutely essential if we expect the student to get the most out of the laboratory work. They represent laboratory teaching at its best. It is, however, impossible for the instructor to do all of these things unless the size of sections is kept within reasonable limits. At Columbia University one laboratory assistant in general chemistry is responsible for sixteen students. At the University of Wisconsin the ratio is approximately the same. How unjust to expect more of a high-school teacher who has not nearly as adequate equipment with which to work.

The Chemistry Student Should Have Some Knowledge of Physics

It is to be hoped that the time is not far distant when some knowledge of physics is required for admission to courses in elementary chemistry. For more and more, modern chemistry is using physical terms and laws, and without such a requirement the chemistry teacher must devote a large part of his time to the teaching of elementary physics. Look through the index of any up-to-date chemistry text-book and you will find such terms as:

anode	cathode	electrode
barometer	conductivity	electrolysis
boiling point	critical pressure	electrolyte
calorie	density	electron

energy	potential	spectrum
freezing point	specific gravity	vapor pressure
gas pressure	specific heat	x-ray
matter		

If we are to ask the chemistry teacher to devote a large part of his time to teaching physics it is obvious that chemistry will suffer.

Library Facilities

If we asked the history teacher to limit his teaching to his text-book what a howl there would be! And yet that is just the condition that obtains in chemistry in many high schools. One or two text-books from the teacher's private library are the only reference books available, with the result that the student finishes the course with no conception of the tremendous scope of his subject. The distribution of the five books by the Chemical Foundation in connection with the Prize Essay Contest has helped the situation, but is only a beginning. One hundred dollars invested in carefully selected reference books will mean much to the success of the course in elementary chemistry.

I am sure that all of you will agree that the criticisms I have made concerning the deplorable conditions under which many teachers are now working, are eminently justified, and that the improvement of these conditions would result in much better teaching. But you will at once ask, "Why tell this to us? The superintendents and principals are the ones you should talk to." I am not enough of an optimist to really believe that any one person can help matters by simply bringing these conditions to the attention of administrative officers. Recommendations of a local association of teachers might help, but far more influence would be exerted by a national organization such as the American Chemical Society with its 15,000 members, and its JOURNAL OF CHEMICAL EDUCATION, and Division of Chemical Education. The Society is trying to better chemical instruction in high schools and to coördinate college and high-school work by the outlined courses with which most of you are familiar. These outlines have been prepared by some of our ablest chemistry teachers and will have a decidedly beneficial effect on the teaching of elementary chemistry. But a study of the problems that I have outlined is just as important. Recommendations from the Chemical Society concerning such topics as the size of laboratory and quiz sections, the need of free hours for the laboratory teacher and the availability of standard reference books in chemistry would be of greatest value to superintendents, principals, and school inspectors. They would support the demands of the chemistry teacher by supplying him with concrete information as to what the American chemists believe to be the conditions for the most efficient teaching of their science.

A NEGLECTED OPPORTUNITY*

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Scientists, of all people, should be careful in the expression of their ideas. The experimental data and the theoretical concepts of science are exact, and the record of science should be worthy of these—clear, accurate, and complete. This paper is written to call attention to the need, first, of the exercise of more care in the construction of articles to appear in scientific journals, and, second, but more especially, of more criticism on the part of science teachers of the written productions of their students.

The author wishes to state at once that he appreciates fully his own weakness in the two matters mentioned above. To justify, in some measure, his presumption in writing this article, let it be pointed out that the hardened offender can, presumably, give reliable testimony as to some of the elements that may account, in part at least, for his offenses.

This is a plea for accuracy and clearness of expression in written English. Our mental reaction rate varies so much from individual to individual that we may forgive each other some poorly constructed oral sentences and some orally ill-expressed ideas. But a scientifically executed piece of work should not be marred by a published report that is unscientific because it is not clear and complete.

Moreover, this is a plea for accuracy and clearness of expression only. The scientific worker may justly insist that he has no time for attempts to develop in his writing that elusive quality called "style." He has done enough when he has produced writing that conveys to the mind of the reader exactly, completely, and effectively what he wishes so conveyed. If he succeeds in this, perhaps he has actually achieved perfect style!

One of the most tangible and obvious evidences of education is the use of clear and accurate English. Scientific men have the more reason to possess this evidence of education because their daily laboratory activities are such as should lead to the appreciation of the desirability of accuracy and clarity in all matters.

Professor E. F. Smith presumably had the sins of many of the present-day authors of books and articles in mind (not all are sinners, of course) when he called attention, at the Los Angeles meeting of the American Chemical Society, to the high quality of the English of the text-books written before 1830. Professor W. A. Noyes indicated, at the same meeting, that if America is to hold first place in the scientific work of the world, her technical publications must be of the highest order. The world in

* This article was written before the May, 1926, number of THIS JOURNAL was issued with its editorial comment on the legitimacy of instruction in English composition in courses in chemistry. The question of the extent of the responsibility of the teacher of science for the English of his students is evidently a living one and perhaps much good might result from further expression of opinion on it.

general will be able fully to appreciate our work only if the results of it are recorded in the journals in language capable of but one interpretation.

There are many imperfections in our published articles. It may perhaps be contended that some of these are the result of the policy of the *Journal of the American Chemical Society* in which brevity is insisted upon by the editors. If one reads the "Notice to Authors of Papers" printed on the first page of the *Journal*, however, one sees that it is the "utmost brevity consistent with clarity of expression" that is insisted upon. Obviously the editors will allow all the space that is necessary for clearness.

The imperfections then must, in the main, be laid at the doors of the authors of papers. They are not conscious faults, of course, nor are they due to carelessness so much as to the physical and mental weariness of the writer and to lack of appreciation of the fact that these articles are permanent records and therefore should be scrupulously written. It is not part of the author's purpose to attempt to enumerate the imperfections completely. Sometimes there are omissions of various kinds which interrupt the reader's continuity of thought. These are unconsciously bridged by the writer of the article because of his familiarity with the experimental work, but they are often disastrous for the reader, who is not so well-informed. Very often there are poorly constructed sentences and paragraphs and the reader is forced to repeat his reading and finally to decide on the writer's meaning "from the context." Often there are misstatements. The writer makes statements that he does not mean literally, and expects the reader not to accept as his meaning what he has written but what he had in mind when he wrote the sentence! Sometimes articles are unnecessarily technical.

If we are willing to admit that we are offenders in the matters of written English and of the construction of articles, can we do anything toward the improvement of the situation? We can do two things.

First, we can dedicate ourselves to a straighter and narrower path for the future.

Second, we can try to teach our students that scientific work should be reported only in accurate English. This is much the more important point of the two, for we shall here be trying to lead the steps of the young into the right path, thus preventing a perpetuation of the present condition. This point also constitutes the claim of this article to publication in THIS JOURNAL.

The author fears that many teachers may object at first to what may seem to constitute an added burden. Also, many may feel that the teaching of English should be left to the English department. The author thinks, however, that both of these objections are invalid.

The offenses in expression should be pointed out together with the scientific faults. Indeed, the former are scientific faults because they are

sins against accuracy, which underlies all science. The correction of faulty English from this viewpoint is, therefore, a legitimate duty of the science teacher.

Again, is it not a good deal to ask of the English department to make accurate writers in the one or two courses of English composition required of the student? Could the chemistry department make chemists in so short a time? It is the duty of every teacher to do his part in the attempt to finish the great work begun by the English department—that of helping the student to achieve one of the important goals of education, effective expression of thought.

There are many other reasons why the teacher of science should not neglect the written English of his students. Of these, two seem to the author to be of especial weight.

He has an especially good opportunity to supplement the work of the English department. The results of science are perfectly definite and are capable of unambiguous expression. The science teacher is usually aware of much of what the student is trying to write, and can, therefore, often know whether or not the student expresses well what is in his mind. In the case of much of the written matter presented to the English teacher, on the other hand, this is not true; the English teacher often cannot know exactly what the student is trying to write, and so cannot evaluate the written work as to accuracy.

Students who have been forced to write clearly must have thought clearly. If all other arguments fail to make us feel responsible to some extent at least for the written work of our students, we cannot escape the one implied in this statement. Clear thinking is one of the most important goals of education. Training our students to write clearly is training them to think clearly.

It should not be necessary to state that an extreme treatment of this matter of accurate writing is not contemplated in this article. The author once heard of a school principal who was so imbued with the idea that English should be taught in all departments that he insisted on a periodic submission by the teachers of a tabulated report of all errors in the written work of all students. Such a canvass might yield interesting data but would probably call for the cessation of most of the other activities of the staff and would rightly lead (as it did!) to open rebellion.

The science teacher should take the very first opportunity that presents itself to point out to the student the necessity of making a conscious effort to write clearly. The class should be taught at the beginning that scientific results demand scientifically accurate expression. The first note-books and written exercises should be used as examples of what constitutes good and bad writing. But the teacher should not stop there; he should, throughout the year, be continually on the watch against hazy

expression and especially against misstatements such as: "The following reaction took place: $NaCl + AgNO_3 \longrightarrow NaNO_3 + AgCl$." What the writer of such a statement means and should, therefore, write, is: "The reaction represented by the following equation took place: $NaCl + AgNO_3 \longrightarrow NaNO_3 + AgCl$."

Realizing the fact that habits, once formed, are usually permanent; that imperfect and hazy expression is a scientific fault to be overcome with other scientific faults; that the mastery of English is a mark of education; and that we, as scientific teachers, have an especially good opportunity to foster clear thinking in our students by insisting on clear expression of ideas, let us not continue to neglect one of our great opportunities of service.

Gelatin Aids Digestion of Milk and Ice Cream. Gelatin is a protein, but it never would be a very successful meat substitute. Its best use is as an aid to the digestion of milk when other foods are excluded from the diet, Dr. Thomas B. Downey of the Mellon Research Institute has found. Barley water, which is a member of the same class of protective colloids, has long been a common and useful component of the contents of many a baby's bottle.

"Gelatin," says Dr. Downey, "was introduced as an economy food during the period of the French Revolution. In view of the status of the knowledge of nutrition of that day, it is not surprising that there arose exaggerated opinions, both pro and con, regarding the actual food value of the product. It is only in quite recent times that the results of earlier investigations on gelatin as a food can be interpreted with accuracy."

In his experiments with rats Dr. Downey found that it was of decided supplementary use with such natural foods as wheat, oats, and barley but had little value as a major source of protein. Rats fed on milk and the average commercial variety of ice cream picked up considerably in growth and health, however, when gelatin was added to the bill of fare. He concludes that "the effects of gelatin as a colloid of the emulsoid type exert a significant influence upon digestibility and absorption where ingested with these dairy products with the exclusion of other foods. In these particular diets, the colloidal effects of gelatin may be equal in importance to, if not indeed greater than, its value as a protein."—*Science Service*

Star Measuring Device Applied to Microscope. The interferometer, invented by Dr. A. A. Michelson, of the University of Chicago, and used at the Mt. Wilson Observatory to measure the diameters of distant stars, has recently been applied in Germany to the microscope for measuring particles too small to be seen with the ordinary microscope. The method depends on the fact that when the light from a very minute source, either because of its actual small size, or, as in the case of the stars, because of its great distance, is split into two beams, and recombined, a series of light and dark "interference" bands results. By the measurement of these bands, the diameter of the source of light may be computed.

Prof. Michelson suggested that the method could also be applied to the microscope, but, so far as is known, the work of the German scientist, U. Gerhardt, is the first time that the suggestion has been carried out. It is stated that by means of the microscope interferometer, objects half as small as can be seen ordinarily may be measured. The smallest particle actually measured was about 1/125,000 of an inch in diameter, while theoretically, one-half this size could be measured.—*Science Service*

A STUDY OF THE COMPARISON OF DIFFERENT METHODS OF LABORATORY PRACTICE ON THE BASIS OF RESULTS OBTAINED ON TESTS OF CERTAIN CLASSES IN HIGH-SCHOOL CHEMISTRY

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The recent studies[1] in the comparison of methods of presenting high-school laboratory science have attracted the attention of teachers and administrators. The results of these studies do not well agree with the teachers' idea of the comparative value of demonstration and individual laboratory work. Opinion generally seems to favor the individual method; the evidence as presented by these studies seems to favor the demonstration method. Administrators are interested in this problem not only from the instruction standpoint but also from the financial; not only in the purchase of equipment and supplies but also in the construction of new buildings.

There have been certain objections raised to the studies as made, in that the number of classes concerned was in each case small, from two to four; that the actual instruction was performed by the one interested in the results; that the conditions under which the experiment was worked were very unusual and could not be duplicated by the regular class-room teacher in her own class; that some method of evaluating differences found should be used in order to determine whether these differences could be due to chance errors, etc. There may be other objections but these have been noted because the experiment to be described tried to overcome all of these difficulties. The results obtained at the completion of the experiment and stated later in this paper, support many of the findings of those working earlier and bear positive proof of their careful procedure and scientific skill in planning their experiments, collecting their data and calculating results. The experiment,[2] to be described, did not attempt to parallel the work already done but rather to concentrate on certain issues. The results obtained, where they can be compared, do not entirely agree with those of the previous workers but there is marked similarity in many of the findings. There is quite a variation, however, in some of the interpretations of results and the conclusions reached.

The purpose of this experiment was to compare different methods of laboratory practice on the basis of results obtained on tests of numerous classes of high-school chemistry taught by different teachers in different class-rooms and to use some method of evaluating differences, if found, in order to determine whether these differences are real significant differences.

Thirty-four classes[3] from twenty-three different schools coöperated in this study. These twenty-three schools were located in fourteen different states. A very interesting statistical device was used to determine whether differences found on the different methods were significant differences or differences that might be due to chance. This device is called the critical ratio.[4]

The method of conducting the experiment was a modification of Dr. McCall's rotation method of experimentation.[5] This method was selected because such irrelevant factors as teaching skill of teacher and differences in ability of groups are eliminated. Each class could be compared with itself on the different methods and finally by combining all of the classes it was possible to compare the results of the entire group in its success on the different methods.

The following methods of performing the experiments were followed:

1. The demonstration method.
2. The individual method.
3. The group-of-two method.
4. The control method: student takes the examination before he performs the experiment.

The tests as constructed by the author were made on the basis of ten introductory experiments as found in one of our most popular chemistry manuals.[6] The tests are objective as to grading and vary as to the number of questions on each experiment, as to difficulty, and as to the type of the question. Most of the questions are of the multiple choice type. It was the aim of the author so to construct the questions that they would test ability to think in the realm of chemistry as well as to recall specific information.

For convenience the classes were divided into four groups called A, B, C, and D. Classes were assigned to groups by chance except in the case of those schools that furnished more than one class. These assignments, where possible, were made in such a way that classes from the same school would not be in the same group. Each group represented a different scheme of routing by methods. Group A performed the first experiment by method one, Group B by method two, Group C by method three, and Group D by method four. Group A performed the second experiment by method two, Group B by method three, Group C by method four, and Group D method one. This rotation of methods continued through the ten exercises.

On account of the difference in difficulty of the questions and because different numbers of questions were prepared for the different experiments it was necessary to scale the tests in such a way that results on the different experiments would be comparable. This was done by making a distribution of all of the records for each experiment performed by methods one, two, and three combined, and by determining the sigma of each distribution. By means of these sigmas any student's or school's record on the different experiments could be compared.

The sigma position for each student on every experiment he performed in each of the thirty-four classes in terms of the combined distribution of all scores by methods one, two, and three for each experiment, was then cal-

culated. By tabulating the different sigma scores of a pupil under three columns, by methods, it was possible to compare the results of each student on the different methods. By tabulating in this way all of the students for any one class, a comparison of the results on the different methods by this class were shown. By combining all of the classes, three grand total distributions were obtained which represented the results of the entire group by each of the three methods. These three distributions with their means and sigmas are shown in Table I.

TABLE I

GRAND TOTALS OF THE DISTRIBUTIONS OF SIGMA SCORES, BY METHODS, OF ALL THE CLASSES. THE DETERMINATION OF THE MEAN, SIGMA, AND PROBABLE ERROR OF THE MEAN OF EACH DISTRIBUTION

Sigma score, steps	Methods 1	2	3
−2.71 to −3.00	1	1	3
−2.41 to −2.70	6	13	15
−2.11 to −2.40	6	1	5
−1.81 to −2.10	33	21	47
−1.51 to −1.80	39	39	83
−1.21 to −1.50	76	42	83
−0.91 to −1.20	105	91	113
−0.61 to −0.90	123	112	167
−0.31 to −0.60	127	77	114
−0.01 to −0.30	122	134	151
0.00 to 0.29	151	129	174
0.30 to 0.59	160	74	131
0.60 to 0.89	182	158	182
0.90 to 1.19	98	71	117
1.20 to 1.49	110	72	109
1.50 to 1.79	64	46	46
1.80 to 2.09	14	21	11
2.10 to 2.39	6	4	6
2.40 to 2.69	0	0	0
2.70 to 2.99	0	0	2
3.00 to 3.29	1	0	2
Total number	1424	1106	1561
Mean	0.064	0.031	0.064
Probable error of the mean	0.0175	0.0188	0.0174
Sigma	0.98	0.99	1.02

The number of students performing each experiment was not the same because the groups of classes were not equal as to size and because certain classes failed to work certain experiments or in working them did not follow their own schedule of methods.

The mean sigma score for the entire group for method one is slightly higher than the mean sigma score for method two and this in turn is higher

than the mean sigma score of method three. In order to determine whether these differences found are significant differences, the determination of the critical ratio of the differences of the means was calculated. This shows us (Table II) that while there is a difference between method one or demonstration, and method two or individual, yet the difference is so small that it is not significant. However the difference between method three or the group-of-two method, and either of the other two methods is large enough to be considered significant and in favor of demonstration and individual as compared with the group-of-two method.

TABLE II

DETERMINATION OF THE CRITICAL RATIO OF THE DIFFERENCES BETWEEN METHODS ON TOTAL DISTRIBUTIONS OF ALL CLASSES COMBINED

The probable error of the differences between the mean of:

Methods 1 and 2.....	0.026
Methods 2 and 3.....	0.026
Methods 1 and 3.....	0.025

The critical ratios between methods:

Methods 1 and 2.....	1.27
Methods 2 and 3.....	3.65
Methods 1 and 3.....	5.10

When the critical ratio is 3 or more the difference is significant.

A very interesting comparison between method one and method two was made by noting the number of classes doing better on method one as compared with method two. This comparison shows that about fifty per cent of the classes did better on method one and about fifty per cent did better on method two. In this case the numbers are too small to apply the critical ratio technic and the word *better* may mean either better (a significant difference) or it may mean just as good (difference not significant). It should also be considered when a class does *better* on one of these methods that it does not mean every student did *better* but that the class as a whole, measured by the mean sigma score, received a higher score on this method than on the other method. The question arises: Did this equal division of classes appear this way by chance or were factors present that caused one-half of the classes to do better by one method and one-half to do better by another method? If there are certain factors operating here, can they be measured and controlled? As noted above, however, when all of the scores of all of the students as one group are used in the comparison and the differences of the means of the two distributions calculated and the critical ratio determined, we are able to say, that as far as the entire group is concerned the difference is not significant.

When the same comparison is made between methods two and three,

identical results are obtained, as far as the numbers of classes are concerned. Just as many classes did better on method three as on method two, when better is used in the same sense as preceding. However, in this case, when all scores of all students are used in the comparison and the means of the two distributions calculated, there is a difference in favor of method two, and when the critical ratio technic is applied we find that the difference is significant, even though approximately fifty per cent of the classes were able to do as well on method three as on method two.

Conclusions

The results of this experiment point to the conclusion that the majority of students in high-school laboratory chemistry classes, taught by the demonstration method, succeed as well as when they perform the experiment individually, if success is measured by instruments which measure the same abilities as are measured by these tests.

The results of this experiment also indicate that the majority of students in high-school laboratory chemistry classes, performing experiments in groups of two, do not succeed as well as when they perform the experiments working alone, when success is measured by instruments which measure the same abilities as are measured by these tests. The practical difference between the results obtained from the individual method and the group-of-two method, while significant, may not justify the additional expenditures of equipment and material required for individual work.

There are probably other abilities not measured by these tests or any tests yet constructed that will rank the individual method higher than the demonstration method. We have as yet no adequate test for scientific attitude, appreciation, manipulative skill in handling apparatus, or scientific method of procedure. Conclusions of a very general nature cannot be made about the comparative worth of these methods of instruction studied here unless we limit our statements to the certain abilities measured. In terms of these other abilities and values, which we are quite certain are being developed, but which are not included in this study, no comparisons are attempted.

The Significance of These Conclusions

As mentioned earlier in this article there are two school groups particularly interested in a study of this type, the class-room teachers and the administrators. It is hoped that administrators, as well as class-room teachers of science, will realize that while the studies in this field so far have shown the value of demonstration as a method of instruction for certain abilities, however, so far as we now know, we must consider the usual laboratory method as one of our most efficient means of instruction. There are today too few laboratories in our high schools, not too many.

Koos[7] studied the floor plans of one hundred and fifty-six proposed high-school buildings and found that only fifty-seven and seven-tenths per cent of these buildings were to be equipped with chemistry laboratories. The situation was even more serious when the other sciences were considered. The percentage of buildings making such provisions for the other sciences were as follows: for physics—fifty-three and eight-tenths; for biology—thirty-one and four-tenths; for science—twenty-one and two-tenths. Will the administrator, in his search for economies and in light of these conclusions, suggest that laboratories be omitted from our new high-school buildings; that individual laboratory work be eliminated and that all science in the high school be offered by the demonstration method? Such a move would indeed be unfortunate.

Probably our laboratories can be made to function more efficiently. Possibly the demonstration will be used more widely as an efficient means of instruction for elementary chemistry. This is not, however, a suggestion to eliminate our individual laboratory work, but the situation does suggest a very careful analysis of the place of the laboratory in high-school chemistry, its aims and purposes, its methods and standards, its cost and efficiency. These and similar problems can only be determined by a scientific method of procedure where conclusions are based on objective evidence and not upon opinions.

Problems Suggested by This Study

This study made no attempt to investigate *why* the group-of-two method gave poorer results than either of the other methods. An opinion as to whether this could be accounted for by the social situation created when two normal high-school children work together or whether one student really did succeed as well and the other loafed or an attempt at any other solution would be merely guesswork and is not attempted. It is interesting to note, however, that Bowers[8] working with students in a teachers' college and its training school was able to say that students work better in groups than individually. The difference in age, intelligence, or purpose of the student or any one of a number of factors, might account for this difference. Would it not be worthwhile to know under what conditions we may expect just as good or better results and the possibility of controlling these conditions in other situations? Possibly our high-school students need training in group activity.

The experiment indicates that there are other factors affecting the accomplishment of the student on the tests which were just as effective in determining his score as was the method used in performing the experiment. These factors may be complex in nature and may include native intelligence, previous preparation, teacher factor, etc. As an example of the importance of these factors the following comparisons are made. It was

noted that although classes were assigned to Groups A, B, C, and D by chance, yet certain of these groups were stronger than other groups; stronger in the sense that they could answer correctly a larger number of questions regardless of the method of instruction. The ranking of the groups through the ten experiments varied but little regardless of the method used. This observation is limited to methods one, two, and three. In the final distributions in this study these factors are eliminated and do not affect the result, since in the final comparison groups were not matched against other groups but the entire group against its own score on the different methods. It would seem, however, that here are factors that should be investigated; factors that seem more positive in their effect on the accomplishment of the student than a change in method, when accomplishment is understood to mean the ability to score on tests measuring the same abilities as these tests measure.

What are the abilities that are developed in the laboratory method of instruction that cannot be as well developed in some other way? Can tests be devised for these abilities in order that we may support our opinions with objective evidence? Would not this bit of evidence be so important that one immediate effect would be the increase in the number of chemical laboratories in our secondary schools?

Who should undertake these and similar problems? The teacher in the class-room, working in coöperation with other teachers and research workers, is in a position as no one else can be to make intensive studies of these situations. That the teachers are willing to do this and glad to make their contribution is shown by the fact that more teachers signified their willingness to coöperate in this study than could be conveniently used.

This study has pointed out and emphasized the need of further study on problems of chemical education. Glenn[9] in a recent article in THIS JOURNAL lists many other problems of interest to the teacher of chemistry.

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[3] The high schools coöperating in this study were as follows: Beardstown, Ill.; Britton, S. D.; Cleveland, Ohio (East High School); Colorado Springs, Colo.; Chicago, Ill. (Lake View High School); Dowagiac, Mich.; Gloversville, N. Y.; Greenville, N. C. (E. C. T. C.); Greenville, S. C.; Horace Mann School for Girls, N. Y. C.; Indianapolis, Ind. (Shortridge High School); Lawrence, Kansas (Liberty High School); Milbrook, N. Y.; Newark, N. J. (The Barringer High School); New York City (The William Seward High School); Rockaway, N. J. (The Lincoln School); Sandy Lake, Pa.; Saratoga Springs, N. Y.; South Orange, N. J.; Sunbury, Pa.; Washington, D. C. (The McKinley Technical High School); Whiting, Ind.; Wilmington, Del.

Two other high schools, The Drury High School of North Adams, Mass., and the Washington High School of Cedar Rapids, Iowa, in addition to the above list, cooperated, but because the tests were received so late in the first semester, the experiment had to be given the second semester, their returns coming in too late to be included in the tabulations. Other schools expressed their willingness to coöperate if additional schools were needed.

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CHEMISTRY AND PHYSICS IN THE DUTCH SECONDARY SCHOOL

H. A. J. PIETERS, ZIERIKZEE, HOLLAND

In my article on "Chemistry in Holland"[1] I tried to give a brief survey of the various institutions in which chemistry is taught. In this paper I shall give a more detailed description of some of those institutions with special reference to the teaching of science.

It is rather difficult to give a brief yet complete summary on the organization of secondary instruction in Holland because, only a few years ago, primary and secondary education underwent a rather sweeping reorganization which is not as yet wholly completed. In addition to the gymnasia, lycea, and state secondary schools which I mentioned in my earlier paper, there is also a number of confessional schools. Many of these have been established since 1920, when a law was passed which secured for this type of school the same treasury grants as are awarded to other schools. School fees are automatically fixed in proportion to the income tax paid by the parents. The pupil who is altogether or nearly "school-free" is also allowed free use of the necessary books. The reorganization has resulted in greater centralization in the administration of school affairs. Particularly is this true in the case of the State Schools, which are regulated almost entirely through the Department of Public Instruction.

At present there are in existence 34 public and 17 confessional gymnasia as well as 15 lycea. The remaining secondary schools fall into the classifications tabulated below. (The figures given are for 1923.)

TABLE I

Type of school	Number	Total enrolment	Boys	Girls
State	47	8434	6147	2287
Municipal	31	7745	5800	1945
Municipal (for girls)	7			1532
Private	8	1037	844	193
Protestant	26	2073	1635	438
Catholic		1408	1397	14
Municipal (3-year)	18	4580	3079	1501
Other 3-year	4	290	197	93
Commercial	24	1329		

The Dutch Secondary School

The pupils enter secondary school at the average age of 12–13 and are instructed in mathematics, biology, three modern languages, history, geography, drawing, and physical exercise. In the third form physics is added to the course while in the fourth and fifth chemistry, mechanics and some other subjects are added.

[1] THIS JOURNAL, **2**, 341–4 (1925).

The distribution of these subjects and the amount of time devoted to each are indicated in Table II.

At the head of each school is a director who carries out the administration and who has the entire responsibility for the standing of the school. The classes contain an average of 20 pupils but never more than 30. Most secondary schools are small, the average enrolment varying between 100 and 400. Subjects are taught preferably by teachers who have taken an academic degree. In addition, teachers must pass special examinations in the subjects they teach. As a rule a teacher gives up to 30 weekly lessons in one subject, except in small schools where physics and mathematics, physics and chemistry, or chemistry and biology are combined. Combinations of mathematics and physics, mathematics and mechanics, history, geography and state institutions, economy and bookkeeping are most frequent. Consequently the number of teachers, the director included, varies from 12 to over 20. The teachers are free in the manner and the extent of teaching within the limits of an official syllabus. They also choose the books to be used. There are six weeks of summer holidays, two at Christmas and nearly two at Whitsuntide.

TABLE II

Subject	Form. I	II	III	IV	V	Number of weekly lessons (50 min. each)
Mathematics	6	6	6	4	4	26
Theoretical mechanics	–	–	–	2	(2)	4 (2)*
Physics	–	–	4	3	3	10
Chemistry	–	–	–	4	4	8
Practical chemistry	–	–	–	–	2	2
Biology	2	2	1	1	2	8
Cosmography	–	–	–	1	–	1
State institutions	–	–	1	1	–	2
Economy	–	–	–	–	2	2
Geography	3	3	2	1	1	10
History	3	2	2	2	2	11
Dutch	4	3	3	2	2	14
French	5	4	3	2	2	16
English	–	4	3	2	2	11
German	4	3	3	2	2	14
Bookkeeping, etc.	–	–	–	1	(2)	3 (1)
Drawing	2	2	2	4	1 (2)	9
Physical exercise	3	3	3	2	2	13
Total	32	32	33	34	33–36	

* The pupils of the 5th are allowed to choose between mechanics plus an extra lesson in drawing and bookkeeping, etc.

The pupils may leave secondary school at the end of the third year to seek employment or to continue their instruction at a technical school or they may continue in the secondary school and submit themselves to a final examination at the end of the fifth form.

The examining board, presided over by the school director, consists of the teachers who have taught the pupil in the fifth form together with five delegates, each a specialist in a certain group of subjects. As each teacher puts questions in his own subject the remainder of the board sits in judgment upon the answers given. The same delegates visit an entire group of schools and the written examination is also the same for all schools, so that a high degree of uniformity in the results of examinations may be expected. When the pupil has passed the examination he is qualified to enter any university. He also has some advantages in seeking employment.

There are only a few boarding schools, all of which are confessional. The rest of the schools are non-residential. In several schools the pupils form school clubs in which the teachers take an interest and render assistance.

The equipment of the schools varies with the number of pupils and is least in the state schools.

TABLE III

RESULT OF FINAL EXAMINATIONS OF HIGH SCHOOLS IN 1924

		Number of candidates			
		Examined		Passed	
	Number of schools	Boys	Girls	Boys	Girls
Public schools	85	1498	511	1355	477
Other schools	37	462	89	417	82
Miscellaneous candidates	...	310	55	237	43
Total	122	2270	655	2009	502

The course in physics adheres to the following outline.

A. First year (3rd form).

Force: Equilibrium, lever, weight, elasticity, tension, friction.

Motion: Force and power.

Fluids at rest: Surface tension, transmission of pressure by fluids, hydrostatics, Archimedes' law, specific gravity.

Fluids in motion: Solution, diffusion, osmosis.

Gases: Weight and general properties, law of Archimedes, pressure of gases, atmospheric pressure, barometer, Boyle's law, pumps, siphon, solution, diffusion and osmosis, kinetic theory of gases, liquids, and solids.

Heat: Temperature, thermometers, expansion laws, determination of coefficient of expansion, correction of barometer reading, laws of Boyle and Gay-Lussac, density and weight of gases, nature of heat, absolute temperature.

Calorimetry: Quantity of heat, specific heat, calorimeter and its use.

Melting and Solidifying: Influence of change of volume, determination of heat of fusion and of melting point.

Solution and heat.

Vaporization: Boiling, vapor pressure, heat of vaporization, estimation of the density of vapors.

Liquefaction: Critical phenomena, practical applications.

Hygrometry.

Transmission of heat: Elementary treatment of the principles underlying the steam engine and combustion motor.

Energy and heat: Mechanical equivalent of heat, extension of the knowledge of molecular theory, preservation of energy, efficiency of engines.

B. Second year.

Sound: Nature of sound, wave-motion, musical scale, transmission of sound, the ear, sonorous bodies, resonance, interference.

Light: Nature of light, reflection, refraction, mirrors, formulas and constructions, lenses, formulas, constructions and defects, dispersion, color, spectroscopy, the eye, spectacles, other optical instruments, photometry, velocity of light, interference, polarization.

Extension of knowledge of molecular theory.

C. Third year.

Magnetism.

Electrostatics: Electrical charge, conductors, properties of electrical charge, laws of Coulomb, hypotheses, induction, electrostatic machines, electrostatic potential, capacity, condenser, electrometer, discharge and lightning.

Dynamic electricity: Experiments of Volta, electrochemical series, voltaic cell, other cells, batteries, electro-kinetics, magnetic field of current, laws and calculations, measuring instruments, heating effect of current, electrolysis, polarization, electromagnetism, telegraphy, electromagnetic induction, telephony, dynamo and motor, transformer, electromagnetic waves, principles of radio-telegraphy, broadcasting, electric discharge, ionization of gases, Geissler effect, cathode and X-rays, radio-activity, constitution of the atom, electrical units.

The pupils not only get a thorough knowledge of the subjects mentioned but must be able to perform calculations based on the theoretical principles learned. The experiments are performed by the teacher except in a few schools where the pupils themselves are allowed to perform some simple experiments.

The standard of the final examination in physics can be derived from the following translation of the 1925 examination:

1925. Time: 3 hours.

A. A dutch spy-glass has an objective the spherical faces of which have a radius of 9 cm., while the refraction index of the glass is 1.5. The ocular is a combination of a bi-convex lens with a focal length of 4.5 cm. and a bi-concave lens with a focal length of 1.5 cm.

When the axis of the telescope is directed towards the center of the moon, calculate the distance of objective and ocular if the observing eye does not accommodate. Also calculate the magnifying power.

Calculate the displacement necessary when the eye of the observer is accommodated for 22.5 cm. Sketch the path of three beams originating from a point in the outer edge of the moon's disk for an accommodating as well as for a non-accommodating eye. In this sketch the ocular can be supposed to be replaced by a single lens with the same focal length.

B. Discuss in detail one of the following subjects:

1. *Boiling:* Difference between boiling and evaporation. Explanation of the singing of water before it begins to boil. The laws of boiling. The estimation of the

height of a mountain from the boiling point of water. Why is the maximum vapor-pressure of water at 100°C. exactly 76 cm. of mercury?

2. *Electrolysis:* The laws of Faraday on electrolysis. The formula of the first law and the significance of the quantities involved. Experiments which prove those laws. Discuss the hypothesis from which the phenomena of electrolysis can be derived. The deduction of the laws from that hypothesis. What is meant by polarization? Discuss an application of it.

C. Define the heat of fusion of ice. Describe an experiment to estimate its value. Give an equation of the calculation of the results of this experiment.

Sketch the path of a beam of light passing through water or glass and falling upon the interface of the water or glass with air. Construct the refracted ray. Is this construction always practicable? Discuss the physical meaning of this mathematical consideration.

What do you know of the fall of potential between the poles of a cell when the current is started? What is the electromotive force of a cell? What connection exists between the two?

Under what conditions will two tuning forks resonate? How is this experimentally proved? Calculate the length of a column of air which is in resonance with a tuning fork of given frequency. How is that length determined by experiment?

The two-years' course in chemistry comprises the following subjects:

A. Inorganic chemistry: The common elements, preparation, occurrence, properties, choosing the most significant reactions, and giving the principles of the most important chemical industries.

B. General chemistry: Hypothesis, theory, law, principle of conservation of matter, law of combining weights, atoms and molecules, equivalent weight and atomic weight, valence, principles underlying the determination of molecular and atomic weight, chemical formulas, calculations, equilibrium, law of mass action, Le Chatelier's principle, solutions, electrolysis, ionic theory, degree of dissociation, complex formation, ionic reactions, ionization of water, hydrolysis of salts, indicators, thermo-chemistry, something about disperse systems, the structure of matter and radio-activity, periodic table of the elements.

C. Analytical chemistry: The reactions are carried out by the pupils in the fifth form together with other experiments at the choice of the teacher.

Qualitative: Group reactions with hydrochloric acid, sulfuretted hydrogen, ammonium sulfide, and ammonium carbonate. Some characteristic reactions on Na^+, K^+, NH_4^+, Ca^{++}, Ba^{++}, Mn^{++}, Fe^{++}, Fe^{+++}, Cr^{+++}, Cu^{++}, Hg^{++}, Ag^+, Pb^{++}, Cl^-, NO_3^-, SO_4^{--}, CO_3^{--}.

Titration: Of acids and bases, iodine with sodium thiosulfate, ferrosalts and oxalic acid with acidulated permanganate, silver ion with chlorine ion.

D. Organic chemistry: Qualitative and quantitative estimation of C, H, N (one method), structural formulas, saturated hydrocarbons, halogen substitutes, alcohols, amines, nitrils, acids, aldehydes and ketones, unsaturated hydrocarbons, a few unsaturated acids, glycerol, fats, soap, dibasic acids, hydroxy acids, optical activity, amino acids and proteins, hydroxy aldehydes and ketones, sugars, starch, cellulose, carbonic acid, urea, cyanogen derivatives, benzene and some of its derivatives, phenols, the derivatives of toluene.

Most experimental work is done by the teacher. There is an amanuensis

who assists the teachers of physics and chemistry and who has the care of the instruments.

The following examination paper gives an idea of the results expected:

1925.

A. 6.35 grams of iodine are dissolved in a solution of potassium iodide in water after which the liquid is diluted with water to 500 cc. With the obtained solution a solution of sodium thiosulfate is titrated, with starch as an indicator. What is to be observed during this titration? When 20 cc. of the iodine solution correspond with 10 cc. of the thiosulfate solution, calculate the strength of the latter. (I = 127.)

What are exothermic and endothermic compounds? What do you know of their decomposition? Give an example of each.

A concentrated solution of cupric chloride is green. What becomes of the color upon dilution with water? Account for this change in color. To the diluted solution concentrated hydrochloric acid is added, with the result that the color becomes green again. Explain.

B. How can we prepare: ethylene from ethyl alcohol; ethylene cyanide from ethylene; succinic acid from ethylene cyanide?

Give the reactions by which we obtain a saturated hydrocarbon from (*a*) one which has one carbon atom more, (*b*) one which has one carbon atom less per molecule.

What is the structural formula of di-secondary-propyl-ether; methyl-ethyl-ketone; mono-methyl-ammonium-chloride?

Give one method of preparing methyl-ethyl-ketone.

Which substances can be formed by the action of one gram mol of chlorine on one gram mol of toluene? Do those substances act with potassium hydroxide. If so, what is the result? What is formed when the product of the action of potassium hydroxide is oxidized?

C. (1) An electric current is passed through a solution of potassium sulfate in water using platinum electrodes. The liquid is colored violet with litmus. What is to be observed? Explain on the basis of the ionic theory. Give an example of a hydroxide which can be an acid as well as a base. How does this amphoteric character reveal itself?

What substance results from the reaction of lead oxide with a solution of lead acetate?

C. (2) Describe the preparation of potassium chlorate by electrolysis.

A silver coin contains silver and copper. How can we prepare pure silver nitrate from it?

Sulfuretted hydrogen is passed through a given quantity of dissolved ammonia until this is saturated. Then the same amount of ammonia is added. What reactions have taken place?

D. (1) Discuss the following reactions:

a. Action of concentrated sulfuric acid on copper.
b. Chlorine and a solution of potassium ferrocyanide.
c. Sulfuretted hydrogen passed through a solution of acidulated potassium bichromate.
d. Sulfuretted hydrogen passed through a solution of ferrous sulfate after which a solution of sodium hydroxide is added.

D. (2) Discuss the following reactions:

a. Action of red phosphorus, bromine, and water.
b. Action of sodium hydroxide on monosodium phosphate.
c. Solution of mercury in dilute nitric acid when part of the mercury remains in excess.
d. Action of nitric acid on a solution of ferrous sulfate to which sulfuric acid has been added.

Crystalline Insulin Requires Long Study. Insulin has been reduced to a purity so great that it comes down out of solution in the form of minute crystals that shine like bits of uncut diamond when viewed through the microscope. Yet this result has not satisfied Dr. John J. Abel and his corps of co-workers at the school of medicine of the Johns Hopkins University. They expect to spend the coming two or three years, at least, investigating the properties of those crystals.

The insulin used in medicine is effective clinically, Dr. Abel told a representative of *Science Service*, but it has been recognized from the first that chemically it is far from being a pure product. Most chemical compounds indicate the attainment of a state of real purity by forming regular crystals, and nobody had been able to get crystals of insulin. The trouble was, Dr. Abel explained, that the insulin was all mixed up with a lot of other unknown substances that would precipitate at very nearly the same electro-chemical state of the solution.

Beginning with the ordinary insulin used in medicine, Dr. Abel and his associates passed it through an elaborate series of precipitations with various chemicals and repeated solutions in weak acetic acid. The crystals that come down at the last stage are very small. After settling out at the bottom of the flask they were picked up with a fine-pointed, rubber-tipped medicine dropper. The process of manufacture is so slow and difficult that months of work have resulted in the preparation of only a few hundred milligrams of the precious stuff.

This pure crystalline insulin is extremely potent, Dr. Abel states. One milligram of it, or a bit as large as a rather small grain of sand, has as much power to reduce blood sugar as is possessed by 100 clinical units of the solution used in medical practice. One fiftieth of a milligram will throw a $4^1/_2$ pound rabbit into convulsions, which are quickly cured, however, by injecting a little sugar solution into the rabbit's veins.

Whenever a chemist succeeds in refining a natural compound to a purity that will result in crystal formation, the next step is usually expected to be the analysis of the crystals, with a view to the possible manufacture of the compound by artificial means, so that a perfectly uniform product may be obtained at a lower price. But Dr. Abel states that a year or more of work must intervene before the analysis can be completed. The synthesis of the compound will undoubtedly be a matter of the greatest difficulty and may be impossible in the present state of our knowledge.

Dr. Abel is no novice in the field of purification of gland secretions. Three of the four extracts of the various ductless glands so far crystallized or brought to a very high concentration are checked up to his credit. In addition to the recent crystallization of insulin, he isolated epinephrin as a mono-benzoyl derivative from the extract of a ductless gland situated near the kidneys, and he has also prepared a highly purified and very potent tartrate, not yet crystallized, from extracts of the pituitary body. The fourth internal gland secretion to be purified is thyroxin, the extract of the thyroid gland of the throat region, which was crystallized by Dr. Edward Kendall of the Mayo Clinic.—*Science Service*

STATUS OF CHEMISTRY TEACHING IN THE SOUTHWEST*

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The states of the great Southwest are normally considered by many people to be without the range of the great industrial centers of the country. To a certain extent it is true that these states do occupy an isolated position in relation to the centers of manufacturing and commerce. Up until the last twenty years their interests were almost entirely restricted to agriculture and grazing.

During the past two decades the industrial activities of this area have increased by leaps and bounds and show every indication of continuing to do so in the future. With the rapid growth of such industries as oil, gas, coal, lead, zinc, asphalt, salt, sulfur, glass, silica, milling, and numerous minor developments, the Southwest must be taken into consideration along with the other states in the industrial activities of this nation.

With this thought in mind the writer considered it worthwhile to investigate the status of chemistry teaching in this area in an effort to determine whether or not the work in chemistry in secondary schools is keeping pace with the industrial development of the section.

The numerous state universities, agricultural colleges, technical schools, and other institutions of like rank seem to be making satisfactory progress in the training of skilled technical men for industrial work. These institutions are manned by well-trained instructors and equipped for the work they are attempting to do. The outlook for chemistry in the colleges in the southwest section is very bright with the greatest problem consisting of finding ways to take care of the constantly increasing numbers demanding admission into the departments.

Let us turn our attention to the secondary schools that are furnishing the freshman material for these colleges.

The state of Kansas has at the present time a total of 725 accredited high schools. Most of these are accredited for four years' academic work. However, a few of them are accredited for only two or three years. Out of this number there are 150 that offer the subject of chemistry as a regular part of their courses of study. This number runs slightly under 21 per cent of the total.

The state of Texas makes the best showing of all in the Southwest in regard to the number of secondary schools offering the subject. Texas has a total of 595 accredited high schools, 117 of which are accredited with the Southern Association of Secondary Schools. Of these 595 schools a total of 257 or 43 per cent offer the subject of chemistry as part of their regular secondary school work. Eighty-five per cent of these Texas high schools do not employ more than eight teachers on high-school courses.

The Texas school authorities recommend chemistry as a third-year

* Paper read at the Tulsa Meeting, April 6, 1926.

subject and are getting it. They further recommend a minimum laboratory supply equipment of $300 for each class of twenty students. Only sixty-three of all schools were reported last year as needing additional laboratory equipment while a total of 301 were reported as having added during the year one hundred dollars worth of equipment or more.

The Texas schools seem to be getting some results from their chemistry teaching. Of the twenty-seven subjects on which Texas students stood college entrance examinations last year, the percentage of failures in chemistry was lower than in sixteen other subjects. The freshmen failures in science subjects in the University of Texas are just slightly higher than the total percentage of freshman failures for the institution. In the Texas Agricultural and Mechanical College the freshman failures in sciences are about half again as high as the general average for the institution.

The writer feels that the Texas high schools are to be especially commended for the progress they are making in science instruction.

Among the high schools of the writer's own state, Oklahoma, the outlook is not so bright. This state has a total of 749 accredited high schools, 96 of which are accredited by the North Central Association of Secondary Schools. Although 240 schools offer physics as part of their curricula, only 90, or twelve per cent of the total number, offer the subject of chemistry.

In fact, the Oklahoma schools have gone wild on the subject of general science. Out of the total of 749 schools, 520 of them offer general science and 198 of them offer this subject to the exclusion of all other sciences with the possible exception of physical geography. Some of us doubt the wisdom of this general rush away from the other science courses to the study of general science.

These facts do not mean that the state is crowded with weak high schools. The truth is there are a large number of high schools in Oklahoma, both large and small, that are splendidly equipped and efficiently operated. The growth and development of these high schools in the last few years has been nothing short of remarkable.

This situation in regard to the teaching of chemistry is due to several causes. The school authorities have met with considerable difficulty in securing instructors who are willing and competent to offer the courses. This is due to a great extent, in the opinion of the writer, to the fact that courses of training for the preparation of teachers in this state are arranged in a great measure to qualify them to become school executives and not instructors. Promising young men and women are met every day who look forward to becoming superintendents, principals, and supervisors, but too few of them are seriously preparing themselves for a permanent occupation in the field of actual instruction. The monetary rewards of the two lines of endeavor are largely responsible for this attitude on their part.

Chemistry is looked upon as an expensive subject to offer and this fact alone keeps it out of the course of study of many high schools. Physics is offered in its stead, partly from custom and partly because the physics supplies have a longer period of usefulness after they are purchased. All superintendents and principals are anxious to have their schools on the accredited list for the benefit of the pupils who wish to transfer work or enter college. Such accredited standing also helps the school executive to maintain his reputation among school people and in the local community as a high-class school man. It is cheaper and easier to get on the accredited list without chemistry than with it, therefore, in many cases chemistry stays off the list.

It is the idea of quite a group of school executives in Oklahoma that in many instances chemistry has been taught in a formal way only and carried with it very little of practical value to either the pupil or the community. Probably in many instances this has been a fact. The subject should be taught in a practical way. However, chemistry teaching that puts too much stress on practical and local applications without proper stress being placed on the fundamentals of the science may easily degenerate into a hodge-podge of isolated facts that make very little lasting impression.

In a bulletin on the teaching of science issued by the State Department of Education of Texas the following statement is found: "A danger in the teaching of chemistry at present is the tendency to over-emphasize the practical phases of the subject. The mistake is often made of attempting to make the approach to new principles through practical applications of chemistry, an understanding of which often taxes even the ability of the teacher. Many so-called 'practical applications' are meaningless without a knowledge of the fundamental principles involved."

In conclusion, it appears to the writer that the leaders in chemical education in Oklahoma have a real task before them in selling the subject of chemistry to the schools of this state. Probably the greatest task of science teachers the world over at the present time is to help bring the level of public information up to the point where the laymen will be able and willing to use the tremendous amount of scientific information that the research workers have developed. If the public schools do not handle this problem, who will?

The need for such instruction is pointed out by Dr. Charles W. Eliot when he says, "Many highly educated American ministers, lawyers, and teachers have never received any scientific training, have never used any instrument of precision, possess no manual skill whatever, and cannot draw, sing, or play on a musical instrument. Their entire education has dwelt in the region of language, literature, philosophy, and history, with a brief excursion into the field of mathematics."

subject and are getting it. They further recommend a minimum laboratory supply equipment of $300 for each class of twenty students. Only sixty-three of all schools were reported last year as needing additional laboratory equipment while a total of 301 were reported as having added during the year one hundred dollars worth of equipment or more.

The Texas schools seem to be getting some results from their chemistry teaching. Of the twenty-seven subjects on which Texas students stood college entrance examinations last year, the percentage of failures in chemistry was lower than in sixteen other subjects. The freshmen failures in science subjects in the University of Texas are just slightly higher than the total percentage of freshman failures for the institution. In the Texas Agricultural and Mechanical College the freshman failures in sciences are about half again as high as the general average for the institution.

The writer feels that the Texas high schools are to be especially commended for the progress they are making in science instruction.

Among the high schools of the writer's own state, Oklahoma, the outlook is not so bright. This state has a total of 749 accredited high schools, 96 of which are accredited by the North Central Association of Secondary Schools. Although 240 schools offer physics as part of their curricula, only 90, or twelve per cent of the total number, offer the subject of chemistry.

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Dr. Eliot further states, "The men who have done most for the human race since the nineteenth century began, through the right use of their reason, imagination, and will, are the men of science, the artists, the skilled craftsmen, not the metaphysicians, the orators, the historians, or the rulers."

It is true that laboratories should be well-equipped. But it is also true that many of the world's greatest chemical industries and chemical departments have come from very inauspicious beginnings. Because an individual or a school cannot work in the best surroundings is no reason why that individual or that school should not work at all.

This article was not prepared as a criticism of school executives, for they are doing what they think best according to the way they see the situation. It is a simple statement of the facts as the writer sees them and leads to the conclusion that it presents a problem that will have to be worked out through the chemistry departments of the colleges of the state.

UNITED STATES CIVIL-SERVICE EXAMINATION

The Unites States Civil-Service Commission announces an open competitive examination for assistant chemical engineer (pulp and paper).

Applications for assistant chemical engineer must be on file at Washington, D. C., not later than July 27. The examination is to fill a vacancy in the Forest Products Laboratory, Madison, Wis., and vacancies in positions requiring similar qualifications, for duty in Washington, D. C., or elsewhere.

The entrance salary is $2400 a year. After the probational period required by the civil-service act and rules advancement in pay without material change in duties may be made to higher rates within the pay range for the grade, up to a maximum of $3000 a year. Promotion from lower to higher grades may be made in accordance with the civil-service rules as vacancies occur.

The technical work of the Forest Products Laboratory at Madison, Wis., includes investigations in pulp and paper mill waste. The chances for advancement are good for those who prove capable.

Competitors will be rated on their education, training, and experience; and writings to be filed with the application.

Full information and application blanks may be obtained from the United States Civil-Service Commission, Washington, D. C., or the secretary of the board of U. S. civil-service examiners at the post office or customhouse in any city.

Odorless Carbon Disulfide. A method for producing odorless carbon disulfide was described recently by Dr. Karl Bohm von Bornegg in the *Chemiker-Zeitung*. The liquid is shaken up with mercury, separated from the mercury and allowed to stand for a short time in the presence of 2 per cent of pure fat. On subsequent distillation, the carbon disulfide is obtained in a practically odorless condition. The mercury treatment may be omitted, but the results are not so satisfactory.—*Canadian Chemistry*

A SURVEY OF THE CHEMISTRY COURSE IN THE OREGON HIGH SCHOOLS

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The Method and Purpose of the Investigation

The investigation of the methods and materials used in the high schools of Oregon was undertaken in coöperation with the Chemistry and the Education Departments of the Oregon State Agricultural College. The following form of questionnaire was sent out to all the standard high schools of the state, excepting only the one-teacher schools which were not teaching the recognized high-school subjects.

1. Underline the science subjects taught in your school and state the year in which they are given: general science..; physiology..; botany..; biology..; physics..; chemistry...
2. How many students do you have in chemistry?
3. How many periods (45 minutes) a week do you teach chemistry?: Lect....; Rec.....; Lab.....
4. State author of text-book and laboratory manual.....
5. If you use outside material in your chemistry course, underline nature of work, such as: library references; agricultural projects; household problems; local industries; community interests; individual problems.
6. What subjects do you teach besides chemistry?
7. Underline any of the following courses you have studied: general chemistry; organic; qualitative analysis; quantitative; agricultural; physical.
8. Name the subjects in which you have majored or studied consecutively for two years.
9. Underline the courses in education you have studied: Principles of high-school teaching; methods of teaching agriculture; methods of teaching science.
10. Underline the obstacles, if any, that tend to limit the interest of the student in the chemistry course: unrelated to student experience; too much theory; not enough laboratory work; insufficient laboratory equipment; lack of library facilities; not enough individual work; too much memory work; subject too formal; teaching too many subjects; state curriculum requirements; college requirements; any others.....
11. Underline changes from present subject-matter and method that would make the chemistry course meet the needs of the students more effectively: use of project method; less formal recitation; elimination of lecture system; adapting course to local needs; relating chemistry to agriculture, to domestic science, or to local industries; any others.....

Any additional information or suggestions bearing on this questionnaire will be greatly appreciated.

The particular aims of the investigation were:

(1) To discover the general conditions under which the chemistry course is being given, such as the school year in which it is offered; the number of the students in the class, and the subjects additional to chemistry handled by the teacher. This is covered by questions one, two, and six of the questionnaire.

(2) To find out the personal equipment of the chemistry teacher.

Questions seven, eight, and nine are designed to discover his training in chemistry, his major studies, and the courses he may have had in methods of teaching.

(3) Questions three, four, and five aim to find out the material used in the chemistry course, such as the text-book, laboratory manual, supplementary, and outside work.

(4) Questions ten and eleven aim to obtain the personal reaction of the high-school teachers of chemistry as to existing obstacles in the course and the possible changes in methods and materials for making it more effective.

General data:

TABLE I

	Sent out	Returned	Giving chemistry	Not giving chemistry
No.	220	103	43	60
Per cent		47	42	58

The number of students represented by the 43 schools or the 42 per cent of the total number of answers is 1466. This number is slightly higher than the number obtained by the previous survey of the State Superintendent of Public Instruction, as published Jan. 28, 1924, in which are given the tabulations of the schedules of all the high-school students. It may therefore be assumed that this survey includes practically all of the schools offering chemistry.

The Conditions under Which the Chemistry Course Is Given

The answers to question one indicate that chemistry is being offered in the third or fourth year. This, however, does not necessarily mean that the students are thereby better prepared to pursue the formal course in chemistry, for among the obstacles enumerated by the teachers in reply to question ten, the following are given:

"Students do not have a foundation in science before taking up chemistry."

"Students often allowed to take chemistry without foundation in mathematics and other science subjects."

Lack of "previous training of students in arithmetic and definiteness of speech."

In reply to question two as to the enrolment of students in chemistry, the number given varies from 7 to 175 students. While the teachers of the large classes in chemistry complain that great numbers in one class tend to limit the interest of the students in chemistry, the teacher in the smaller school feels handicapped by the number of subjects he is called upon to handle besides his course in chemistry. Examples of the diversity of subjects he is required to teach is illustrated by replies to question six, "what subjects do you teach besides chemistry?"

Chemistry, economics, algebra, geometry.
Chemistry, athletics, algebra, general science.
Chemistry, English, Latin, French, athletics, mathematics.
Chemistry, zoölogy, general science, public speaking.
Chemistry and commercial subjects.

The Training of the Chemistry Teacher

TABLE II

TRAINING IN CHEMISTRY

	Replies	Gen. chem.	Organic	Qual.	Quan.	Agricultural	Physical
No.	35	35	27	29	24	1	12
Per cent		100	77	83	69	3	31

TABLE III

MAJOR STUDIES

	Replies	Major in chemistry	Major in education
No.	32	17	10
Per cent		53	32

TABLE IV

COURSES IN METHODS OF TEACHING

	Replies	Prin. of H. S. teaching	Methods in agr.	Methods science
No.	33	33	1	20
Per cent		100	3	61

The training of the teachers in chemistry as shown in Table II, indicates that all the teachers have had general chemistry but the number having had advanced chemistry gradually decreases as the subject advances in complexity. From the number that have had physical chemistry it may be assumed that about one-third of those teaching chemistry in the Oregon high schools have actually specialized in chemistry, since this course is usually given in the junior or senior year of college chemistry and is taken by those who intend to make chemistry a life career.

However, as pointed out by Dewey,[1] since "there are certain features of scholarship or mastered subject-matter—taken by itself—which get in the way of effective teaching unless the instructor's habitual attitude is one of concern with its interplay in the pupil's own experience," the training of the teacher in his special field can be no indication as to what he does with it as a school subject.

The replies to question eight showing the general training of the chemistry teachers are rather difficult to classify. Almost all the subjects included in the college curriculum are mentioned. The majority of the replies, however, indicate a trend toward specialization in science subjects such as physics, biology, and geology. Other major subjects are also

[1] Dewey, "Democracy and Education," MacMillan Co., New York, 1916, p. 215.

given, such as mathematics, languages, sociology, philosophy. Of the teachers replying to this question, 53 per cent have taken chemistry as a major, while 32 per cent majored in education.

However, that the problem of teaching itself is still not considered of particular importance, is indicated by the following reply of a chemistry teacher in one of the largest high schools in the state. He says: "I do not think much of most of the courses in pedagogy. People who can't pass a good stiff science course take education and tell those who have taken such a course how to teach it. I believe the subject should be developed from the scientific standpoint and require the student to rise to that. Something hard won't hurt them." Apparently this advocate of a "scientific course in chemistry" still identifies the benefit derived from a subject by the student, by the degree of difficulty the subject presents. His attitude, typical of many teachers, is that "How to teach," or the presentation of a subject is not important but that the subject-matter itself is the important thing, provided it's hard enough.

Table IV, tabulating replies to question nine, shows that all of the teachers have had courses covering the general principles of high-school teaching, since such courses are a prerequisite for the granting of the high-school teacher's certificate. A large percentage have also had courses in methods of science teaching. However, until the methods in education, as taught by advanced educators, are actually carried over into the schoolroom, the science of teaching will remain of theoretical rather than of practical value.

The Materials and Methods Used in the Chemistry Course

The methods and materials used in the chemistry course are shown in the replies to questions three, four, and five. The tabular representation to these answers is as follows:

TABLE V

(Number of Replies 35)

Schools	%	Lect.	Schools	%	Recitations	Schools	%	Lab.
1	3	3	1	3	1	2	6	2
2	6	2	6	18	12	2	6	3
7	20	1	19	54	3	23	66	4

TABLE VI

(Number of Replies 40)

Author of text	Schools using	%
McPherson & Henderson	34	85
Morgan & Lyman	5	13
Brownlee & Others	4	10
Black & Conant	1	2

TABLE VII

OUTSIDE MATERIAL

(Number of Replies 30)

	No.	%
Library references	15	50
Agricultural projects	1	3
Household problems	7	24
Local industries	15	50
Community interests	11	37
Industrial problems	16	53

The answers to question 3, as shown in Table V, indicate that the lecture method is not popular in the Oregon high schools. Only 20 per cent give one lecture a week. The most common form of procedure seems to be the three periods of recitation and four of laboratory. In accordance with the requirements of the state course of study, most schools use the McPherson & Henderson text.

Table VII shows that outside material is used to some extent. While this is significant, still outside material or the student's environment seldom forms the nucleus of the course and is merely brought in to make the existing course in chemistry more palatable. The reverse or "logical" procedure is the rule—the course exists completely formulated by the state requirements or in the text and the teacher may either transmit this material as such or he may, if he is humanely disposed, sugar-coat this undesirable pill, by bringing in illustrations from the student's environment.

Existing Obstacles and Desirable Changes in the Chemistry Courses

In reply to question ten asking what obstacles, if any, tend to limit the interest of the student in the chemistry course, the following were given:

TABLE VIII

(Number of Replies 30)

Obstacles given	No.	%
Unrelated to student experience	10	33
Too much theory	6	20
Not enough laboratory work	5	16
Insufficient laboratory equipment	16	53
Lack of library facilities	14	47
Not enough individual work	3	10
Too much memory work	1	3
Subject too formal	4	12
Teaching too many subjects	9	30
State curriculum requirements	1	3
College requirements	0	0

In addition to the obstacles suggested in the form of the questionnaire itself, the following obstacles were given by the teachers: Five stated that

the students have a poor foundation in science and other subjects; two that the text is poor; one that the subject is not applied to everyday problems of life and two others that there is a lack of coöperation between chemistry and other departments of the school.

In this connection it is significant to note that no recognition was given by the teachers to the last obstacle listed in the questionnaire, namely, college requirements. Yet it is historically known that the chemistry course was handed down from the colleges to the high schools and as it won a place in the high-school curriculum its recognition by the college depended on how far the high-school course fulfilled its entrance requirements. The tendency has, therefore, been to standardize the high-school chemistry course for the benefit of prospective college students. Thus, while the teachers recognize the obstacles inherent in the organization of the course, the source of the difficulties which can be traced to the influence of college requirements, seems to have been entirely overlooked by them.

The constructive criticisms for making chemistry teaching more effective, as called for in question eleven, are tabulated in the following table:

TABLE IX

(Number of Replies 25)

Changes suggested	No.	%
Use of project method	11	44
Less formal recitation	8	32
Elimination of lecture system	4	16
Adapting course to local needs	10	40
Relating chemistry to agriculture	8	32
Relating chemistry to domestic science	9	36
Relating chemistry to local industries	12	48

As to suggested reforms, Table IX shows that the teachers recognize the possibility of improving the course in chemistry by making the course less formal, less didactic and by relating the course to problems dealing with the home, the farm, and the community.

Summary

The following outstanding facts present themselves in summarizing the data as furnished by the questionnaire: lack of preparation of students in the sciences before taking the chemistry course; the teacher of the small high school is often handicapped by having to handle a variety of unrelated subjects; wide variation in the training of the teacher both in chemistry and education courses, disclosing in some cases inadequate preparation for the handling of the chemistry course; the seeming unpopularity of the lecture system; the use of outside material which, however, does not indicate its inclusion as an integral part of the course but

more often as illustrative material or to popularize course; the obstacle mentioned and changes recommended by the teachers indicate general dissatisfaction with existing methods of presenting chemistry and show a leaning toward the project method.

The data here presented brings into focus the following general conditions governing the teaching of the chemistry course, which no doubt, would probably be found existing in other schools, similar to those covered by this survey.

1. The course in chemistry as given in the high schools of the state is mainly a text-book subject.
2. The text is an abbreviated college text, differing mainly in the volume of its contents, and the material is presented from the point of view of the specialist for the purpose of satisfying college entrance requirements.
3. The teacher is obliged to present the course strictly as outlined by the state high-school curriculum which emphasizes the standards set by the college entrance requirements, thereby limiting the teacher from bringing his own teaching experience and initiative to the development of the course.
4. Under these conditions, the student's viewpoint cannot be given due consideration in the presentation of the chemistry course, so that the course remains largely unrelated to the student's experience, needs, environment, and capacity.

Soil Science Congress to Be Held in U. S. The United States will be host to an international congress of soil scientists in 1927, according to a notice appearing in *Science*. Problems of soil physics, soil chemistry, soil bacteriology and biology, agronomy, and geology will be discussed by specialists from many foreign countries as well as by scientists from American institutions.

The first international conference of soil scientists was held at Budapest in 1908, and the second at Stockholm in 1910. Due to the war and other disturbances, no further meetings were held until 1922, when the third conference met at Prague. The fourth was held in 1924 at Rome.—*Science Service*

Oil of Wintergreen Found Poisonous Internally. Oil of wintergreen, commonly used in salves and liniments, is extremely poisonous when taken internally even in moderate doses. Drs. N. C. Wetzel and J. D. Nourse report that quantities of less than two fluidounces have resulted in death.

The toxic effects of this familiar drug, in frequent use in medical practice to allay pain and reduce fever, seem not to have been generally recognized. They are ascribed to the fact that oil of wintergreen, after being taken into the body, undergoes very little chemical destruction or breaking up into less dangerous components.

Editorial comment in the *Journal of the American Medical Association* says that from the standpoint of public welfare, "Access to oil of wintergreen should be made impossible for children and for persons ignorant of its poisonous properties."—*Science Service*

A COMPARATIVE STUDY OF THE USE OF DIPHENYLAMINE AND POTASSIUM FERRICYANIDE AS INDICATORS IN TITRATIONS WITH POTASSIUM DICHROMATE

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As a standard solution for use in iron determinations potassium dichromate has many advantages over potassium permanganate. It can be obtained in a very pure condition, the solution is easily made, is very constant, and can be used in the presence of chlorides. The one big disadvantage has been that until recently no suitable inside indicator has been available and the tedious procedure known as Penny's method[1] using potassium ferricyanide on a spot plate has had to be used.

J. Knop[2] proposed the use of diphenylamine which gives an intense blue color at the instant of complete oxidation of all ferrous salts. The interference of the troublesome yellow color of ferric chloride he avoided by the use of a mixture of sulfuric and phosphoric acids. The phosphoric acid here acts as it does in the Zimmermann-Reinhardt solution, suppressing hydrolysis of ferric chloride and causing the formation of the poorly ionized ferric phosphate, which is not highly colored.

The present work was undertaken to give Knop's method a thorough try-out and to see what sort of results it would give in the hands of students. The students were sophomore chemical engineers and the work was carried out in connection with their regular course in quantitative analysis. Comparative analyses were made on each sample by both the Knop and Penny methods. The results obtained by the instructor, J. P. Mehlig, are also given.

Solutions Required in Titration

1. Approximately 0.1 *N* potassium dichromate solution.
2. A mixture of sulfuric and phosphoric acids made as follows: 150 cc. sulfuric acid (d. 1.84) is mixed with 150 cc. phosphoric acid (d. 1.7) and the mixture diluted with water to 1000 cc.
3. Diphenylamine solution, consisting of 1 gm. of diphenylamine dissolved in 100 cc. concentrated sulfuric acid.

Standardization of Potassium Dichromate

The potassium dichromate solutions were standardized against Mohr's salt using both the spot plate and the diphenylamine method. In each case about 1 gm. of Mohr's salt was dissolved in 50 cc. of recently boiled and cooled water. For the spot plate method 15 cc. 6 *N* sulfuric acid were added and enough water to make a total volume of 100 cc. For the diphenylamine method 25 cc. 6 *N* sulfuric acid, 15 cc. of the sulfuric-

[1] *Chem. Gaz.*, **8**, 330 (1850).
[2] *J. Am. Chem. Soc.*, **46**, 263 (1924).

phosphoric acid titration mixture, and three drops of indicator were added and the total volume made up to about 200 cc. A correction of 0.05 cc. for the oxidation of diphenylamine was subtracted from the volume of standard dichromate solution added as suggested by Knop. In most cases a slightly lower normality factor was obtained with diphenylamine. The average of fourteen different solutions was 0.1013 *N* by the spot plate and 0.1012 *N* by diphenylamine.

Analysis of Ferrous Salts

The determination of iron in ferrous salts was carried out in the same manner as the standardization of the dichromate solution. In each method the corresponding normality factor was used in the calculation. Table I shows the very close agreement that was obtained. All results are averages of closely agreeing duplicate determinations.

TABLE I

ANALYSIS OF IRON IN FERROUS SALTS

	Mohr's salt, 14.23% Fe	
	Spot plate % Fe	Diphenylamine % Fe
Student A	14.18	14.21
Student B	14.19	14.11
Student C	14.24	14.16
Student D	14.20	14.23
Student E	14.21	14.20
Student ave.	14.20	14.18
Mehlig	14.25	14.21
	Ferrous sulfate, 20.08% Fe	
	Spot plate % Fe	Diphenylamine % Fe
Student F	20.01	20.00
Student G	20.02	19.91
Student H	20.14	20.12
Student I	20.10	20.10
Student J	20.24	20.25
Student K	20.05	20.13
Student L	20.17	20.16
Student ave.	20.10	20.10
Mehlig	20.10	20.08

Analysis of Chromium in Steels and Ores

Knop[3] found that, since the presence of a large amount of ferric salts does not have a bad effect on the end-point, it was possible to use this method in the determination of chromium in chrome steel by dissolving a steel sample in 1:1 sulfuric acid, oxidizing the solution by ammonium persulfate, filtering off the precipitate of $MnO(OH)_2$, and determining the

[3] *Loc. cit.*

chromic acid formed by adding excess of 0.1 *N* ferrous sulfate solution, and titrating back with standard dichromate solution.

We have applied this method to the determination of chromium in chromite ores in our laboratory with very satisfactory results. The ore was fused with sodium peroxide and the melt dissolved in water, acidified with sulfuric acid, and the excess peroxide destroyed by boiling. The old method calls for filtration of the ferric hydroxide before the solution is acidified. This filtration is very laborious, tedious, and slow even with suction, and it is almost impossible to wash the residue at all, to say nothing of washing it sufficiently. Excess solid Mohr's salt was added to the acidified solution to reduce the dichromate and the excess immediately titrated with standard potassium dichromate solution, using 30 cc. titration mixture and three drops of diphenylamine. Student results are given in Table II.

TABLE II

CHROMIUM IN CHROMITE

	% Cr present	% Cr found
Student A	28.22	27.98
Student B	22.86	22.83
Student C	22.86	22.72
Student D	31.42	31.37
Student E	31.42	31.55
Student F	31.42	31.45
Student G	32.35	32.10

Analysis of Ferric Salts Reduced with Stannous Chloride

While either potassium permanganate or potassium dichromate may be used with good results in the titration of simple ferrous salts, in the case of ferric salt solutions which have been reduced with stannous chloride solution, the permanganate method, commonly called the Zimmermann-Reinhardt method, leaves a great deal to be desired and gives results depending upon many factors not easily controlled. In Penny's dichromate method, however, chlorides do not interfere and it is possible to apply to the analysis of ferric salts the dichromate method using diphenylamine as indicator, giving a method which is rapid and accurate and which avoids the faults of the Zimmermann-Reinhardt method.

In our laboratory we formerly had considerable trouble with the Zimmermann-Reinhardt method as it usually gave results of from 0.5% to 1.00% higher than the spot plate dichromate method. This trouble was finally corrected by running a blank titration with the standard permanganate solution on the Zimmermann-Reinhardt solution. The blank usually requires from 0.80 to 1.20 cc. of 0.1 *N* permanganate solution. By use of blank correction, results that agree well with the dichromate method can be obtained.

Our procedure for ferric salts was as follows: The solution of ferric salt acidified with hydrochloric acid was heated nearly to boiling and reduced with 5% stannous chloride solution, quickly cooled, and 25 cc. 5% mercuric chloride solution added to oxidize the excess stannous chloride, giving a precipitate of mercurous chloride. Fifteen cc. of the titration mixture and three drops of diphenylamine were added, and the whole diluted with water to give a volume of about 200 cc. and titrated with standard dichromate solution. Table III gives Mehlig's results. No student analyses were made. 0.02% is the largest difference between the spot plate and diphenylamine methods.

TABLE III

ANALYSIS OF IRON IN FERRIC SALTS

	% Fe present	Spot plate % Fe	Diphenylamine % Fe
Ferric nitrate	13.82	13.91	13.92
Ferric alum	11.58	11.70	11.68
Ferric sulfate	26.47	26.37	26.35
Ferric chloride	20.12	20.10	20.10

The spot plate method was carried out in the usual manner. Although half a dozen determinations were run the figures for ferric alum are just a little high, due to the fact that the sample had lost a small amount of its water of crystallization.

The diphenylamine method was also applied to the analysis of iron in iron wire. The weighed sample, about 0.26 gm., was dissolved in 25 cc. concentrated hydrochloric acid, and a gram or two of potassium chlorate was added to oxidize the hydrocarbons. The solution was then reduced with stannous chloride and treated just as in the case of the ferric salts. Mehlig's results follow:

Fe present: 99.70%. Fe found by spot plate: 99.56%, 99.65%; by diphenylamine: 99.82%, 99.82%.

Analysis of Iron Ores

For the analysis of iron in ores about 0.5 gm. of ore was digested, but not boiled, with 25 cc. concentrated hydrochloric acid and reduced, without removing the silicious residue, with stannous chloride and titrated as in the case of the ferric salts. The ores used were Diack and Smith analyzed samples and the figures in the first column of Table IV were obtained by their analysts by the permanganate method. In the cases of ores No. 7 and No. 8 not quite all the iron in the ore was dissolved in the acid. No attempt was made to fuse the residue. But even here as in the case of each of the other ores the diphenylamine figures are in close agreement with those of the spot plate method.

TABLE IV

ANALYSIS OF IRON IN ORES

	% Fe present	Spot plate % Fe	Diphenylamine % Fe
Ore No. 1			
Student A	37.62	37.34	37.32
Mehlig	37.62	37.53	37.51
Ore No. 2			
Student B	36.84	36.83	36.89
Student C	36.84	36.87	36.89
Mehlig	36.84	36.82	36.74
Ore No. 3			
Student D	36.12	36.18	36.14
Mehlig	36.12	36.10	36.09
Ore No. 4			
Student E	35.11	35.13	35.09
Mehlig	35.11	35.11	35.12
Ore No. 5			
Student F	34.45	34.52	34.44
Mehlig	34.45	34.43	34.43
Ore No. 6			
Student G	56.27	56.21	56.20
Mehlig	56.27	56.14	56.17
Ore No. 7			
Student H	54.08	53.51	53.52
Student I	54.08	53.96	53.95
Mehlig	54.08	53.62	53.60
Ore No. 8			
Student J	51.52	51.77	51.78
Mehlig	51.52	51.30	51.22
Ore No. 9			
Student K	49.59	49.57	49.61
Student L	49.59	49.58	49.44
Mehlig	49.59	49.63	49.56

Summary

1. The use of diphenylamine as an indicator in the determination of iron with potassium dichromate solution gives results that agree very closely with those obtained by the Penny spot plate method.

2. The diphenylamine method gives excellent results for either small or high percentages of iron.

3. The method gives excellent results with beginners as well as with more experienced analysts.

4. The method is especially applicable to the determination of chromium in chromite, avoiding the slow and tedious removal of ferric hydroxide by filtration.

THE SEPARATION OF PHOSPHATE ION IN QUALITATIVE ANALYSIS

R. C. CANTELO, UNIVERSITY OF CINCINNATI, CINCINNATI, OHIO

Most courses in elementary qualitative analysis include a separation of Groups 3, 4, and 5 in the presence of a soluble phosphate. In most schemes of analysis directions are given for the removal of the phosphate ion as ferric, chromium, and aluminum phosphates from a solution which contains acetic acid and ammonium acetate, *i. e.*, from a solution containing a low concentration of hydrogen ion. The excess of iron added, over that needed stoichiometrically to combine with the phosphate ion is precipitated as basic ferric acetate, and at the same time a part of the aluminum and chromium may also precipitate as basic acetates.

The equations representing the reactions taking place are given as follows:

$$FeCl_3 + Na_2HPO_4 = FePO_4 + 2NaCl + HCl$$

$$FeCl_3 + 3NH_4C_2H_3O_2 = Fe(C_2H_3O_2)_3 + 3NH_4Cl.$$

When boiled,

$$Fe(C_2H_3O_2)_3 + 2HOH = Fe(OH)_2C_2H_3O_2 + 2HC_2H_3O_2.$$

Similar equations may be written for the separation of aluminum and chromium. The precipitate obtained is large and bulky and the filtrate amounts usually to 350 to 400 cc., this necessitating an evaporation to a volume of about 30 cc.

This method has been found unsatisfactory by the writer's students when barium ion is present, and to a lesser extent when strontium ion is present. The inference is that the barium ion is adsorbed by the bulky precipitate described above. Unknowns containing barium have been unsuccessfully examined by students who have reported no difficulty when using the method now to be described.

Baskerville and Curtman in their "Qualitative Analysis" make the statement:

> "Metallic tin, when added to a nitric acid solution of a phosphate, precipitates the phosphate as stannic phosphate, the excess of tin separating at the same time as insoluble metastannic acid. This reaction..... may be employed for the separation of the phosphate radical from the metals."

The following procedure based upon the above reactions has proved most successful with elementary students in qualitative analysis.

Evaporate to dryness the filtrate from the copper and tin groups. Add 5 cc. of concentrated nitric acid and again evaporate to dryness in order to remove all the hydrochloric acid present. Then add 25 cc. of dilute nitric acid and some C. P. granulated tin. This removes phosphate ion as insoluble stannic phosphate [$Sn_3(PO_4)_4$] while the excess tin is precipitated

as metastannic acid. Heat gently for 10 minutes, then add 100 cc. water, boil and filter. Wash the precipitate well. The filtrate now contains the metals of Groups 3, 4, and 5, while the precipitate is rejected. The filtrate may now be analyzed by any of the standard methods.

Syphilis Serum Tried in Germany. A new treatment for syphilis, using a preparation made from artificially cultured germs, is being tried at the Kaiser-Wilhelm Institute for Experimental Therapeutics. Though the authorities caution against oversanguine expectations, they state that "the first results are wholly encouraging and give occasion for a thorough-going test of the new method."

The development of the new treatment was made possible by the devising of a method for cultivating the germs of syphilis in test tubes in the laboratory. Efforts in this direction had hitherto not been very successful. Prof. H. Reiter of the Institute tried a fluid medium consisting of equal parts of normal salt solution and rabbit blood serum, with a small amount of rabbit or guinea-pig brain tissue added. In this he succeeded in getting an abundant growth of the spirochetes or germs of syphilis.

Parts of these cultures, with the germs carefully killed, were injected into the skin of children suffering from active syphilis and gave a very prompt reaction, though it had no effect on patients with latent forms of the disease. It was then tried on advanced cases of progressive paralysis, with encouraging results. German medical men are watching further progress of the tests with interest.—*Science Service*

Science Fills Dictionaries with Greek and Latin Words. The advance of science is changing language as well as modes of living. The classical origin of many of the words science is bringing into use is throwing this element in the language into preponderance.

Some 66 per cent of the real functioning words in the dictionary today can trace their ancestry to Latin or Greek. Just the opposite was true fifty years ago, when the majority of words in common use were of Anglo-Saxon origin. Proponents of classical education have here a handy argument with which to bolster up the tottering hold of Greek and Latin on the curricula of present-day schools.—*Science Service*

Vitamin Deficiency Studied Experimentally. Insight into the real mechanism of scurvy, beri-beri, and all the diseases caused by a lack of vitamins is the goal of a group of workers in the Hygienic Laboratory of the U. S. Public Health Service.

In the Division of Pharmacology, M. I. Smith, W. T. McClosky, and E. G. Hendrick have been dosing devitaminized rats with various toxic drugs to see how the reaction of the avitaminous organism varies from the normal. How the functions of the different organs of the body are physiologically altered by a lack of vitamins is an aspect of the vitamin subject that has thus far received very little attention.

These workers have found what might be reasonably expected—that the ability of the tissues of vitamin-deficient animals to resist poisons is considerably reduced. The susceptibility of animals that have been deprived of vitamin A, which is necessary for health and growth, and the anti-neuritic vitamin B, to several nerve poisons indicates a general impairment of the nervous system. The markedly decreased resistance of vitamin A deficient rats to morphine suggests, according to the authors, that the respiratory center is weakened by a lack of this essential food element.

"Sluggish circulation and weakened respiratory center," say the authors, "would account satisfactorily for the frequent occurrence of pulmonary congestion and lung disease in rats on vitamin-deficient diet."—*Science Service*

Chemical Digest

AN UNDEVELOPED METHOD IN CHEMISTRY TEACHING

At a recent meeting of the Education Group of the Chicago Section of the American Chemical Society Dr. Freud of Armour Institute presented a paper on "An Undeveloped Method in Chemistry Teaching." The following points were elaborated:

1. There is merit in correlating class-room instruction with industrial experience.
2. The usual method of doing this in chemistry is accidental, not deliberate.
3. It is done not by the teacher, but by:
   (*a*) lecturers brought in from the industries, and
   (*b*) inspection trips to the industries.
4. The results of these appeals are worthless because they are not planned and organized into formal teaching methods.
5. Teachers in schools of applied chemistry have had to make the appeal in a formal way. Their various methods.
6. A properly planned and conducted inspection trip.
7. The use of this method in high-school teaching.

R. O. M.

Superior Children Pushed Too Rapidly, Warns Educator. Children who show a natural tendency to be superior mentally should not be pushed ahead through school grades too rapidly, is the warning given by Dr. William T. Root, professor of educational psychology at the University of Pittsburgh.

The great trouble with home training is the fact that so many parents like to point with pride to the school achievements of their children, and lose sight of the great importance of a balanced program for the child, says Dr. Root in a report in a forthcoming issue of *Childhood Education*. A balanced program, he declares, must include plenty of play and social contacts with other children of the same age.

Dr. Root urges that health and physical adjustment of the mentally superior child should be given first consideration, and that its superior learning ability should be utilized by more extensive and intensive study rather than by advancing pupils several grades in school. Study of art or music or some other useful subject in which the child happens to be interested is suggested as a means of keeping the bright child occupied.

In warning parents and teachers against grouping superior children in with older, more socially mature children, he points out that the child is so easily molded in the early and formative years that it should be given every opportunity to develop those worthwhile traits of character which can be brought out only by careful social contacts and avoidance of instilling intellectual priggishness.—*Science Service*

ABSTRACTS

The Dynamic Model of the Chemical Bond and Its Application to the Structure of Benzene. LINUS PAULING. *J. A. C. S.*, **48,** 1132–43 (1926).—The author begins by giving a brief but very clear comparison of conceptions of valence based on both the atoms of Langmuir and Bohr. He further suggests that classification of substances as ionic and molecular is far more satisfactory than as polar and non-polar. He then elaborates the idea first suggested by Knorr that non-ionized molecules possess electrons rotating in orbits which include both atomic nuclei. In ionic compounds the valence bond is the result of the transfer of an electron from one atom to the other. In molecular compounds the valence bond results from the sharing of pairs of electrons. In an ionized compound such as HCl, the orbits of the valence electrons are deformed toward each other but do not include the two nuclei. In molecular HCl both nuclei are enclosed within the e'ectronic orbit. The following picture of benzene is then advanced: The six carbon atoms and six hydrogen atoms lie in the same plane at the corners of two concentric regular hexagons. Each carbon atom is connected by two shared bonds as described with the two adjacent carbon nuclei and by a third such bond with a hydrogen nucleus the distribution of these bonds being similar to that about carbon atoms in the carbonate ion and in graphite. Furthermore, each carbon atom is connected with the carbon atom directly opposite by its fourth bond, consisting of two electrons rotating in long orbits about the two nuclei. The six crossed orbits form a stable arrangement, accounting for the stability of the ring. Similar structures are proposed for naphthalene and anthracene. A. P. B.

The Effect of Air in the Jones Reductor. W. L. BURDICK. *J. A. C. S.*, **48,** 1179–81 (1926).—All teachers of quantitative analysis are very familiar with the precaution given to students that the Jones reductor must not be allowed to drain during use. The author questions this precaution and, in an interesting series of determinations, data of which are given in full, seems to have proved that the precaution is indeed unfounded. Titrations were made with a closed reductor, then with an open reductor, then with a reductor which was allowed to drain completely several times, and all results check within 0.2%. For all titrations 0.1 *N* permanganate was used, and ferrous iron was the reducing agent. Further tests to disclose the optimum conditions for hydrogen peroxide formation show that when the column of amalgamated zinc is covered either with dilute acid or hot water and a rapid stream of air passed through for one minute, none is formed. With water at 20°C. enough is formed to decolorize 0.5 cc. of 0.1 *N* permanganate solution. Pure oxygen does not change the results in acid or hot water but larger amounts are formed with water at 20°C. The conclusion of the author is that under the ordinary conditions of analysis, no hydrogen peroxide is formed in a Jones reductor, and open reductors are used at Stanford, the results being entirely satisfactory. A. P. B.

The Valence of Nitrogen and Hydrogen. A. A. BLANCHARD. *J. A. C. S.*, **48,** 1195–9 (1926).—An interesting article bringing out the perplexing difficulties with which a chemist is immediately confronted when he attempts to define the term valence. Polar and non-polar valences are discussed and structures are proposed for the nitrogen molecule, ammonia, and ammonium compounds. A. P. B.

A New Micro Method for Determining Carbon in Organic Compounds. H. L. LOCHTE. *J. A. C. S.*, **48,** 1301–5 (1926).—Wilde and Lochte [*J. A. C. S.*, **47,** 440 (1925)] described a rapid and accurate method for determining carbon by combustion of the sample in a calorimetric bomb, absorption within the bomb of the CO_2 and subsequent determination of the carbonate formed by volumetric methods. One of the authors now describes the method, somewhat modified, to determine carbon when only a few milligrams of sample are available. Nitrogen and sulfur are found not to interfere but the bomb is corroded when chlorine compounds are burned. The time required for a complete analysis is 50–60 minutes, and the time per sample is considerably less when a series is run. A. P. B.

The Significance of the Ether-Drift Experiments of 1925 at Mount Wilson. DAYTON C. MILLER. *Science*, **63,** 433–43 (1926).—According to the theory of Fresnel the luminiferous ether is at rest in free space and in opaque bodies while in moving transparent bodies the ether moves with a velocity less than the velocity of the body in the ratio N^2-1/N^2, where N is the index of refraction. This last is considered to have been proved by the experiments of Fizeau and of Michelson and Morley on the velocity of light in moving media. The idea of a stationary ether in moving opaque bodies has always been in doubt. Attempts to prove the existence of a stationary ether were first made by Professor Michelson in 1881 and by others later. The earth in its orbital motion around the sun was presumed to move freely through the ether as though it

were absolutely stationary in space. If such were the case it is argued that the apparent velocity of light would vary according to whether the observer is carried by the earth in the line in which the light is travelling or at right angles to it. The relative motion between the earth and the ether which these experiments proposed to determine is often spoken of as "ether-drift." The absolute velocity of the earth relative to the ether is not known as it is composed of the orbital velocity of the earth around the sun which is 30 km. per second and the unknown velocity of the whole solar system in an unknown direction.

It is not possible to measure the velocity of light in one direction exclusively as all methods of measurement require the ray of light to travel to a distant point and return along the same path. A positive effect in one direction would be neutralized by a negative effect in the opposite direction.

It has been shown, however, that for a moving observer the velocity of light coming and going in the direction of the earth's motion would differ from the velocity of light coming and going at right angles to the earth's motion in the ratio of the square of the velocity of the earth to the velocity of light, that is, by an amount equal to about one part in one hundred million. The interferometer invented by Professor Michelson causes a beam of light to be split by a half silvered mirror, the two halves to travel at right angles to optically equidistant points and return along the same paths to the starting point. If any difference of velocity is present the two halves of the beam will not reunite "in phase" but in such phase relations as to produce "interference fringes." Observation of these fringes enables the observer to detect slight changes in the velocity of light.

In the present experiment a new interferometer, with a light path of 214 feet was used. As the absolute direction of the motion of the earth is not known the instrument was mounted on a base which floats on mercury and can be turned to all azimuths of the horizontal plane in an effort to determine the direction of the drift. The motion of the earth on its axis causes the plane of the interferometer to take many different space orientations. It is only the component of the drift which lies in the plane of the instrument at the moment of observation that can be observed. A relative motion of the earth and the ether equal to the orbital velocity of the earth (30 km. per second) would cause a displacement of the interference fringes in this instrument equal to 1.1 fringes. Experiments were begun with this instrument in somewhat different form by Morley and Miller in Cleveland in 1902 and continued to 1916. After Professor Morley's retirement in 1906 the work was carried on by the author. The instrument was later moved to Mount Wilson and observations taken in 1921, and again in 1924 and 1925. All experiments up to this time had been designed to test the theory of an absolutely stationary ether and this assuming for the earth only its axial and orbital motions together with a motion of the solar system toward the constellation Hercules with a velocity of about 19 km. per second. The experiments gave a negative answer to the theory, but indications of a difference in velocity of light as observed in different directions were obtained.

Beginning in 1925 an attempt was made to determine the direction and magnitude of the motion of the earth relative to the ether, independent of any "expected" result.

At Cleveland readings requiring 1200 turns of the instrument were made, at Mount Wilson previous to 1925 about 1000 turns were made while in 1925, 4400 turns involving more than 100,000 readings and 12,500 single measures of the "drift" were made.

Calculations from these observations indicate that the earth is moving relative to the ether with a velocity of 10 km. per second toward a point in the constellation Draco which has a right ascension of 262° and a declination of +65°. The probable error in the velocity does not exceed ±0.6 km.

No effect of the orbital motion of the earth could be detected. In view of this it is assumed that the absolute motion of the solar system is greater than two hundred km. per second in the direction indicated but that the relative motion of earth and ether at Mount Wilson is only 10 km. The part of this 10 km. per second due to the orbital velocity of the earth (± 0.6 km. per second) would be just too small to be detected. The two hundred km. velocity is given as a probable minimum. More recent observations have sustained these conclusions. Independent work in other lines by other men also indicates a motion of the solar system in the same general direction and with a velocity of the same order of magnitude. The evidence that the earth drags the ether with it to a considerable extent will require some readjustment of present theories. Numerous curves are given in the article. G. H. W.

The Isolation of Insulin. CASIMIR FUNK. *Science*, **63**, 401–2 (1926).—A purified insulin solution gives with flavianic acid a compound of constant composition. Insulin

flavianate-picrate, picrate, hydrochloride, and finally pure insulin were made from it. The compounds, including the last, are crystallizable. It is predicted that the structure of the compound will turn out to be a polypeptide containing about 15 amino acids. G. H. W.

A Test for Classification of Students in Chemistry. WINIFRED F. HYDE AND J. P. GUILFORD. *J. Appl. Psych.*, **9**, 196–202 (1926).—A description of a test containing two parts, a psychological test and a chemistry information test, and how it was used to classify first-year college chemistry students in order to eliminate failures. The psychological test given at beginning of school year saved about half of failures in beginning chemistry by placing them in a more elementary course. It concludes that a psychological test given to freshmen is of more value for predicting success in college than are examinations on high-school subjects. S. R. P.

Scientific Selection of Books for the School Library. CARLETON WASHBURNE AND MABLE VOGEL. *Educ. Adm. and Superv.*, **12**, 14–6 (1926).—A brief description of how the "Winnetka Graded Book List," now published by the American Library Association, 86 East Randolph Street, Chicago, was prepared by a thorough-going statistical investigation. The preparation of the "Winnetka Graded Book List" is of considerable importance as it makes for greater efficiency in selection of suitable books for school libraries. S. R. P.

Determining Principles of Curriculum Construction. BOYD H. BODE. *Educ. Adm. and Superv.*, **12**, 217–28 (1926).—The problems of curriculum revision and reconstruction are vital ones in all of the various branches of education. It is only through scientific investigation and discussion that we can hope to clarify these problems. This article attempts to evaluate certain viewpoints of such outstanding curriculum theorists as Dewey, Charters, and Bobbitt. S. R. P.

Don't Overload Curriculum Makers. DAVID SNEDDEN. *Educ. Adm. and Superv.*, **12**, 298–304 (1926).—A reply to the article of Boyd H. Bode that appeared in the April, 1926, issue. It takes issue with statements made bearing upon the problems and principles of curriculum construction and offers other points of view. S. R. P.

The Ability of the States to Support Education. JOHN K. NORTON. *Res. Bull. Natl. Educ. Assoc.*, Vol. IV, Nos. I and II, 88 pp. (Jan. and Mar., 1926).—The question of Federal aid in financing public education is one of long standing in the N. E. A. The desirable extent and proper method of applying Federal financial support of public education can be answered only on basis of facts. This bulletin presents comprehensive data showing the ability of the states to meet their educational obligations.

It first presents a comparison of the economic resources of the states, the indices of economic power being the value of tangible wealth and the amount of average income of the states. Then with the number of children six to thirteen years of age in a state selected as the measure of the educational obligation of the state, it determines the relative ability of the state to support education by dividing the various measures of the state's economic power by its number of children six to thirteen. The data presented reveal significant differences among the states to support public education. For example, when considered in groups, the twelve richest states of the forty-eight are three times as able to meet their educational obligations as the twelve poorest states.

Chapter 4 presents data on relationships between the educational situation in a state and its economic ability to support schools. It is shown that there is considerable agreement between the ability to support education and the support actually accorded. This is followed in Chapter 5 by data on some unmeasured factors affecting the ability of states to support education, such as population, density of population, and cost of living.

Throughout, the results are presented in tabular and graphical form, making for ease in interpreting the mass of data given. It is a significant scientific contribution to education and should be especially valuable to students of school finance. S. R. P.

Institute of Chemical Engineers Confers on Education. EDITORIAL STAFF REPORT. *Chem. & Met. Engr.*, **33**, 210 (1926).—A full account of the proceedings of this meeting will appear in the "Transactions of the American Institute of Chemical Engineers." The following definition of chemical engineering, adopted by the Institute in 1922, expresses the basis for the discussion: "Chemical engineering, as distinguished from the aggregate number of subjects comprised in courses of that name, is not a composite of chemistry and mechanical and civil engineering, but itself a branch of engineering, the basis of which is those unit operations which in their proper sequence and coördination constitute a chemical process as conducted on the industrial scale." Professor Badger, University of Michigan, emphasized the necessity for a uniform system

of nomenclature for the various units of the curricula of chemical engineering, so that fair comparisons may be drawn between different schools. Professor James, Ohio State University, declared that "the preparation for college as carried out by the public high school is not as good as it was twenty years ago." Other speakers discussed qualifications desired in teachers of the subject in question, length of the course, laboratory practice, and local administration. V. R. THAYER

The Romance of Carbon. ARTHUR D. LITTLE. *Ind. Eng. Chem.*, **18**, 444–51 (1926).—L. has included in a brief sketch an outline of the entire role played by carbon in nature. The story begins with atmospheric dust, and the soot nuisance suffered by large cities proceeds next to charcoal and its uses, and in a semi-technical style presents interesting and pertinent information concerning graphite, diamonds, combustion and the oxides of carbon, carbonates and their geological origin, the climatic influence of carbon dioxide, a bird's eye view of organic chemistry, carbon as a source of energy, coal, natural and manufactured fuel gases, petroleum products, and asphalt. V. R. THAYER

Research in the Petroleum Industry. BENJAMIN T. BROOKS. *Ind. Eng. Chem.*, **18**, 518–22 (1926).—Brooks says that the extant scientific knowledge concerning petroleum is so meager that investigators are often uncertain of their ground and must sometimes try apparently blind leads. He discusses the work of the American Petroleum Institute, and gives data on the magnitude of the petroleum industry. The major research problems at present are considered to be the development of vacuum distillation; study of lubrication value or "oiliness;" identification of fluorescence, oxidation of petroleum oils; reactions of cracking; production of alcohols from the unsaturated compounds which are removed by sulfuric acid; reactions with sulfur; details of the nitro paraffins; and production of gums from the waste diolefins. V. R. THAYER

"Some Day You Will Tax It." EDITORIAL. *Glass Ind.*, **7**, 119 (1926).—The editor considers that the news most important to American industry during April, has been the announcement of the National Research Endowment. Statesmen and other national leaders have organized to back fundamental scientific investigation. The absorption by applied science of many of the most capable young technical men, to the consequent detriment of pure research, has made such a step necessary. The title, a retort by Faraday to a member of Parliament who asked of what use was the newly invented electrical transformer, illustrates the point. V. R. THAYER

Wanted: A New Glass at a Low Price. EDITORIAL. *Glass Ind.*, **7**, 118 (1926).—Increased illness in Atlantic seaboard cities during the coal strike may be logically attributed to lack of sunshine due to soft coal smoke, which absorbs especially the needed short wave-length or ultra-violet rays, from light. Permanent detrimental effect to urban population may similarly result from continuous indoor life forced upon office and factory workers. The danger could be avoided if modern buildings, wherein the steel framework carries the load, were copiously provided with large windows of glass capable of transmitting ultra-violet rays. The editor is confident that time and insistent demand will bring forth such a glass. V. R. THAYER

Student Guidance Requires Centralized Direction. ANON. *Nation's Health*, **8**, 278 (1926).—According to T. A. Budd of the Wharton School of Finance and Commerce, University of Pennsylvania, a very important problem of the university, aside from instruction, is the giving of suitable guidance to the student in planning his course of study and adjusting his routine of life. To serve the function of advising students as to their curricular choice, of preventing ambitious but indigenous ones from assuming more burdens than they can carry, of coördinating needs in physical development with the program of physical education, and giving moral and ethical advice, if needed, Budd recommends a special department of student personnel, such as exists in the Wharton School. This department keeps a complete record of the student, beginning with his preparatory education, and amplified during the college career by detailed reports from each of his instructors. Points considered include scholastic standing, manner of dress, poise, aptitude, reaction towards criticism, health, and others. V. R. THAYER

The Frontiers of Industry. EARL P. STEVENSON. *Sci. Mo.*, **22**, 285–9 (1926).—Research, wisely directed, adequately financed and sustained in the face of obstacles should receive more attention by our industries. In support of this S. points out that a foreign company is now reaping profits in the viscose silk industry because American industry failed to recognize the earning power of research and the wood distillation industry in this country faces the possibility of losing its investment because it failed to see the value of research until the new German process for making methanol from

water gas began to replace one of its important products. Processes used in America are too generally imported as is evidenced by the following industries dependent on foreign processes: the by-product coking of coal, which in 1924 recovered values to the amount of one hundred and four million dollars formerly wasted by our beehive ovens; the flotation of ores not amenable to economic treatment by our purely mechanical processes; the fixation of atomospheric nitrogen; the viscose process for artificial silk; the basic syntheses of dye manufacture; both the Bessemer and open-hearth processes of the iron and steel industry and the sulfate process for pulping wood. Our concern, S. believes, should be to scan the volumes of scientific literature for suggestions of significance to the solution of current problems. He suggests only two of the many problems that need organized industrial research of this kind, *viz.*, methane as a possible enrichment substance for water gas and synthetic rubber as a possible utilization of the diolefines that are now a source of trouble to the oil refiner who must dispose of them, and his method is by destroying them. G. W. S.

Research, the Prime Mover of Industry. MAURICE HOLLAND. *Sci. Mo.*, **22**, 289–301 (1926).—H. states that the electrical industry was one hundred years in developing from the discovery of electricity to mass production in industry, then asks why the "time lag." He gives as the successive stages in development: First, discovery in pure science research; second, applied science; third, invention; fourth, industrial research; fifth, industrial application; sixth, standardization; and seventh, mass production. The electrical, the textile, the automobile, the radio, the electrochemical, the telephone, and the iron and steel industries and electrical illumination are briefly traced. In each case it was pointed out that the "time lag" was reduced to about fifty years by the introduction of research late in their development. The lack of appreciation of the importance and value of research compared to other industrial aids such as advertising, publicity, etc., is indicated by the fact that eleven dollars per capita is spent for advertising, five for jewelry, twenty-one for automobiles and parties, and only eighty-seven cents per capita for research. He then points out some of the outstanding research achievements of representative laboratories and finds the "time lag" has been reduced to less than five years. Among these are mentioned the loud speaker in which quantity production began within a year after preliminary study of the factors involved; the new vapor-phase process for cracking petroleum, within four years after the general conception of the process came: Duco, in three years after the du Pont people learned how to increase the total solids without making the material too thick to apply. That research pays dividends is shown by the fact that about seventy-five million dollars income tax is paid by ten companies whose names are synonomous with large and completely organized research departments. G. W. S.

The Autobiography of Denis Zachaire: An Account of an Alchemist's Life in the Sixteenth Century. (1 plate.) TENNEY L. DAVIS. *Isis*, **8** [2], 287–9 (1926).—A very interesting story of his effort to transmute metals into gold and a probable satire on the "Writings of the Alchemists and the Methods of Reasoning Which They Employed." F. B. DAINS

The Individual in Mass Education. CARL E. SEASHORE. *Sch. and Soc.*, **23**, 269–76 (1926).—"Keep the child busy at his highest natural level of successful achievement and he will be happy, useful and good." The author has been field representative for the National Research Council and has done much investigating of present educational conditions. He feels that a more thorough investigation of entering classes will result in each student being better orientated and his course so planned as to lead him into studies where he will do the best work and gain the most. He further advocates sectioning the students according to ability, training, etc.; laboratory freedom and the project plan of instruction. This plan is for the first two years of college only, the honors courses being recommended for the last two years. This will lead to a more balanced education. K. S. H.

The Junior College Movement. GEORGE F. ZOOK. *Sch. and Soc.*, **23**, 601–5 (1926).—An address given by Prof. Zook before the Harvard Teachers' Assn. Dr. Zook feels that the junior college has proved a forward movement in education and that there is a growing tendency to establish and maintain junior colleges in connection with the public high schools. Along with the two-year courses comprising the first two years of our present four-year liberal arts courses there are completion courses of one and two years which should be offered in a properly organized system of junior colleges working in close coöperation with the high schools. Working toward this objective would lead to substantial progress in uniting general secondary education and vocational and technical education. These colleges must be closely supervised

to assure high standards. California now has such a system and Texas and Massachusetts have recommended such a step. This movement would take care of many students whose abilities are not such as to permit extended study and thus leave more advanced work to more capable students. The whole movement is so valuable as to warrant careful experimentation with it. K. S. H.

Why Do Persons Go to College? RAY B. HOLLINGSHEAD. *Sch. and Soc.*, **23**, 565–8 (1926).—An attempt to learn from freshmen who have just arrived at college, why they are there. In the fall of 1924, a questionnaire was distributed to freshmen in eight different universities and colleges of Colorado. Replies received totaled 2567, approximately 78.2 per cent of the total registration for the first half year of 1924–25. The results obtained indicated that the child of a professional man has 20 times, and the child of a merchant 8 times the chance for a college education that the child of a laborer has.

The question as to what influence on college attendance was attributed to various persons with whom the freshmen had associated was answered in various ways—from "none" to "very much," the most influence being attributed to fathers engaged in liberal and technical professions. As to a comparison made between the influence exerted by fathers and mothers who had and had not attended college, the college mothers came first, the non-college mothers second, the college fathers third and the non-college fathers last. Both male and female students credited the mother with greater influence than the father. The influence of high-school principals, teachers, relatives, friends, employers, etc., was found to be much lower than that of the parent.

Among the various reasons for attending college, "personal desire," "desire to go away from home," "scholarships," "no particular reason," "more fun than to work," etc., were listed. However, 67 per cent indicated future concern; 33 per cent indicated immediate purposes; 34 per cent showed interest in personal culture or development; 28.4 per cent—"to gain more knowledge;" 19.4 per cent—"to grow socially;" 13.3 per cent showed a definite obligation or concern for society.

About 7 out of every 10 stated that they were preparing for professional careers; 2 out of every 5 indicated a desire for the higher and better paying positions; 16% of the female students admitted they were preparing through collegiate training "to become independent if necessary." The financial status showed that 60% of the men and 26% of the women students were required to work part of their way through college. That women are less likely than men to delay entrance into college after graduation from high school, is another interesting fact. K. S. H.

Sour Milk. NICHOLAS KOPELOFF. *Am. Mercury*, **8**, 61–3 (1926).—The fact that the health and long life of the Bulgarian peasants has been generally attributed to drinking yogurt led Metchnikoff to his theory of replacing the harmful bacteria of the large intestine by beneficial bacteria, *Lactobacillus bulgaricus* (grown in milk). These bulgaricus germs would not, however, remain alive and active for any length of time and so bacteriologists soon discovered what the author calls a twin brother to *Lactobacillus bulgaricus*, *Lactobacillus acidophilus*. Identical in most of its characteristics: coagulating milk, fermenting the sugar into lactic acid, etc., but different in the one most important characteristic—that it survives in the human intestine. It was found that when present in sufficient numbers it was capable of inducing the bacterial transformation of which Metchnikoff had dreamed.

The author speaks of the patent and household remedies for constipation as being, on the whole, both unsatisfactory and habit forming; of medicinal treatment as tedious, but of the acidophilus milk as a "happy solution to the problem." He cites several cases and in answer to the question, "Is its continual use required?" states that individuals vary, though on the whole the treatment is more or less lasting. The treatment depends largely on the successful implantation of large numbers of living organisms.

The milk is almost identical with buttermilk in appearance, taste, consistency, etc. It is prepared by inoculating sterilized milk with *L. acidophilus* and incubating at about 95°F. for 36 hours. According to the author, the commercial preparations of *L. acidophilus* are of a defective nature and do not contain an adequate number of living germs. It would require 20 tons of the tablets or 7 to 8 gallons of the liquid cultures daily to get the same strength present in a quart of the milk described above. The article states that the reason this type of milk has not been more generally accepted and recognized as a necessity is because the medical profession and public have not been educated to recognize the necessity of having larger numbers of living organisms than are generally present in the preparations on the market. K. S. H.

The Dilemma of Chemotherapy. L. M. HUSSEY. *Am. Mercury*, **8**, 180–3 (1926).—Another few years and two decades will have elapsed since the discovery of

salvarsan, an organic compound of arsenic and the first drug to conquer syphilis, at least in its initial stage. For three centuries prior to the advent of chemotherapy only one chemical of use in the treatment of a major disease was unearthed and that was quinine for malaria. A specific for tuberculosis has been predicted but as yet is not even in sight. A quinine derivative, ethylhydroxycuprein, was found to be highly toxic to the bacterium of pneumonia but in attempting to employ it, clinicians discovered that in most cases it affected the vision of the person and many times resulted in blindness. Many substances like mercurochrome have a deadly effect on some germs but to many others are indifferent. According to Ehrlich, one of the collaborators responsible for the discovery of salvarsan, this compound has an affinity for something in the germ molecule and in the presence of this compound the molecules are so altered that they no longer function as a living entity. Consequently the syphilis organism dies. It has been found, however, that this reaction takes place only within the body, salvarsan having no effect on the germ outside the human body. It is therefore apparent, though as yet has not been demonstrated, that the combination between salvarsan and the germ takes place only after the salvarsan has been chemically modified in the body.

The author stresses the fact that despite the immense amount of research in chemotherapy, comparatively little has been discovered and points out that without some directive theory, chemotherapy is apt to remain a groping process of trial and error. The notion of simple chemical reactions between drug and bacterium has not only checked but hindered the inquiry into what must be a much more complex process of interaction. He believes that chemotherapy will emerge from its present dilemma only when the physicist and chemist get together, maintaining that the reactions of living organisms are as much physical as chemical. K. S. H.

The Psychology of High-School Science and the Making of Science Teachers. HERBERT BROWNELL. *Sch. Sci. Math.*, **26**, 528–34 (1926).—The growing emphasis, noted in educational psychology, to distinguish between the psychology of the teaching of science subjects and that dominating the teaching of other subjects promises betterment in training science teachers for their work. Author notes, however, that special instruction upon the psychology of teaching science presupposes a working knowledge of sciences to be taught and of the related sciences and, therefore, that discussions of such psychology belong in the science department rather than in the psychology department. Thus psychological principles may be applied directly in methods courses and teacher-training courses in sciences, and this will result in unification rather than dismemberment in teacher training because either science instructors must be acquainted with the teachings of educational psychology or the psychologists must become masters in the field of science.

As an aid to realization of this two-fold preparation for science teachers the author suggests that colleges establish a course in "The Teaching of Science," taught by someone who can see science as a whole and requiring of the student prerequisite courses in both the physical and biological branches of science. Such a study should come late in the college course to accomplish the greatest good. B. H. B.

The Ability of High-School Pupils to Select Essential Data in Solving Problems. BENJAMIN W. DAILY. *Teachers' College, Columbia University, Contributions to Education No. 190*, Bureau of Publications, New York City **1925**, viii + 103 pp.—We are constantly faced with problematic situations, some of them being well-defined with all the data at hand for their solution but in the great majority of them pertinent facts are absent, forcing us first to select data.

This monograph presents facts pertaining to the ability of high-school pupils to select essential data in solving problems. While the study is devoted entirely to first-year algebra, the results apply equally well to chemistry, a subject that requires a large amount of problem solving. Chapter II is an analysis of texts revealing the lack of problems to be solved where insufficient data is given. This is followed in Chapter III by a study of the effect of introducing problems which contain superfluous or insufficient data among problems with which children are familiar showing that pupils are unaccustomed to problems in which they must find the necessary data. In Chapter V is given a description of experiments conducted to test the effects of appropriate instruction on the abilities to select essential data and to detect absence of data. The experiment revealed the fact that pupils can be taught to select from data of an algebra problem those which are essential for its solution and to demand sufficient data when they are missing from the problems. The final summary and conclusion gives a brief but excellent treatment of certain principles of modern psychology and education, especially "transfer of training." S. R. P.

The Artificial Change of Mercury into Gold. WILHELM HILLER. *Naturw. Monatsh. biol. chem. geograph. geol. Unterricht*, **23**, 80–8 (1926).—A review of the past attempts to transmute elements. H. thinks Miethe's results stand. Work just completed by W. B. Kay using mercury as a target in an X-ray tube and bombarding it with electrons having a speed $^2/_3$ that of light gave negative results. Kay thinks Miethe's results are due to gold as impurity in the mercury. R. E. P.

The Relation of Feeblemindedness to Education, Citizenship, and Culture. MARY M. WOLFE. *Am. Rev.*, **4**, 197–203 (1926).—This paper was read before the American Association for the Study of the Feebleminded, May 8, 1925. A clear and readable presentation of the research work being done in this important field. The author shows how a better understanding of defectives, a method of testing for their degree of mental weakness, and the subsequent training based on this research will solve many educational problems. K. S. H.

Art and the X-Ray. ALLEN BURROUGHS. *Atlantic Mo.*, **137**, 520–7 (1926).—The use of the X-ray in the examination of old paintings is described. Its use is based on the fact that a sensitized film will record the shadows of material objects according to their opacity to the ray. B. divides the total density of the complete picture into three parts: the surface paint, the ground preparation for painting, and the background. A number of old paintings of the Fogg Museum at Harvard University along with some imitations and repaints was examined. The difference between the new and old paint was easily detected. The X-ray is not infallible in distinguishing the old from the new but is of much value. It has no deteriorating effect on the painting. G. W. S.

Coöperation between Industry and University. GEORGE D. MCLAUGHLIN. *Sci. Mo.*, **22**, 281–4 (1926).—After pointing out the field of each, McL. discusses the cooperative plan of the Tanners' Council and the University of Cincinnati. The Tanners' Council is composed of the leather manufacturers of the U. S. The agreement provides: (1) no research work shall be undertaken which is not of strictly fundamental character; (2) the Council will furnish the funds needed for the prosecution of the work; and (3) the results of all research will be freely published in reputable scientific journals. During the four years in which the arrangement has been in effect the laws underlying the curing of animal skins have been established, also those governing the "soaking" process. The arrangement has been so successful that the Council has built and equipped upon the University campus a laboratory building which it has given to the University. One floor of the building is to be devoted to chemical studies, another to bacteriology, and a third to histology. G. W. S.

The Business Administration of a City School System. HARRY PEARSE SMITH. *Teachers' College, Columbia University, Contributions to Education No. 197*, Bureau of Publications, New York City, **1926**, ix + 127 pp.—This monograph presents a study of two types of administration of city school systems, the unit type in which the administration is unified in one chief executive officer and the multiple type in which there are two or more coördinate executive officers each directly responsible to the Board of Education. Chapter II gives a detailed analysis of typical business activities such as budgeting procedure, financial reporting, purchase of supplies, etc., under the two types of administration, revealing significant differences. In Chapter III an analysis of school costs is made and on basis of statistical treatment concludes that the type of administrative organization does not materially affect the cost of education in larger cities. In Chapter IV administrative relationships in multiple type cities are analyzed showing the weaknesses of the multiple type of organization for administration, ten weaknesses being clearly analyzed. Chapter V presents summary and conclusions, the main conclusion being that "there should be for a city school system unified administrative control centered in one executive officer whose point of view is primarily educational." S. R. P.

A Study in the Selection of Subject-Matter in the Field of Health Education. MARION O. LERRIGO. *Teachers' College, Columbia University, Contributions to Education*, Bureau of Publications, New York City, **1926**.—A study to formulate a list of important health problems and to compare with this list courses of study now in use in health education. It presents an analysis of books and reports representing eight different types of authority. Courses of study and text-books were analyzed to determine present practice in health education.

The most striking differences are in the ranking and relative importance given to personal and to public health problems. The present tendency in schools seems to be to place greatest emphasis on personal hygiene, while this study found the control of infections the most pressing need. The fact that such differences exist between

needs and practices should cause the makers of courses of study to examine very carefully the basis upon which a selection of subject-matter is made. S. R. P.

Comparative Psychology and Hygiene of the Over-Weight Child. KATHRYN MCHALE. *Teachers' College, Columbia University Contributions to Education No. 221,* Bureau of Publications, New York City, **1926.**—A comparative study of three body weight groups of children to determine the relation in the over-weight group between mental potentialities and weight, pounds and achievements, and the causes of weight. The parasitic role of body fat and the causes of body weight (life habits, pituitary, and thyroid adiposity) are reported from the literature. Data from a selected group of 11-year old boys and girls were collected on racial and social origin, anthropometrical measurements, physical and health history, basal metabolism status, intelligence and achievement status, personal data (emotionally, etc.), and interests The over-weight group was slightly superior to the normals in strength of grip which is considered an index to general bodily strength and they possessed more speed with the right hand. Few, if any, differences exist among these groups. Over-weight children are similar to other children in most of the attributes which were studied. S. R. P.

Digest of Job Analysis and Curriculum Construction in the Metal Trades Industry. WALTER BENTON JONES. *Teachers' College, Columbia University Contributions to Education No. 227,* Bureau of Publications, New York City, **1926.**—This study presents the development of a technic in job analysis for the construction of a curriculum to train apprentices and other new employees in the metal trades industry. It is based upon a single occupation (pattern maker's trade). The facts and skills necessary for success in this vocation are determined and worked out in steps for the curriculum for training teachers. The problem is divided into a series of ten steps, beginning with the formulation of objectives followed by various steps in constructing the curriculum to finally measuring the results of instruction. It is a noteworthy contribution to the job analysis procedure of curriculum construction. S. R. P.

Biology in Secondary Schools and the Training of Biology Teachers. CHARLES WILLIAM FINLEY. *Teachers' College, Columbia University, Contributions to Education No. 199,* Bureau of Publications, New York City, **1926,** 79 pp.—This monograph presents an historical study of the teaching of biological sciences in the high school and the training of biology teachers. Part I deals with a history of the aims of botany, zoölogy, physiology, and general biology followed by a review of studies relating to the status and sequence of biology in the high school. Part II is devoted to "The Training of Biology Teachers" first describing the conflicting views between the "professional-minded" and academic-minded people interested in teacher training. It presents a treatment of the collegiate preparation; teaching load and training in the sciences of biology teachers and states that most biology teachers are college graduates; that subject-combinations in teaching programs are quite varied; that their training in the sciences is not adequately meeting their vocational needs. It gives recommendations of committees, educators, and institutions on professional training of high-school teachers followed by a survey of teacher-training courses in biology. The study concludes with recommendations for a program of training of biology teachers. S. R. P.

The New Dawn in Education. JOHN JAY CHAPMAN. *Forum,* **75,** 606 (1926).—Such rapid changes as we have undergone during the last fifty years, changes in every form of education and avocation never took place before in any nation except through external conquest. The most palpable change which began to come over us about seventy years ago was the gradual but steady fading out of influence of the thoughtful classes in the country. Piety and the respect for past history and for human experience were all but lost with us. We lived ever more and more in the present.

It was Dean West of Princeton who first called the country to its senses by his indefatigable activity in the cause of true scholarship. It is worth noting that this resurgence of humanism appeared first in a university, the place where in theory it ought to have arisen. Many people think, however, that in America a well-defined zero is to be discerned in our own seats of higher education. We must look abroad into the lives, homes, and occupations of our people to find where the fires have gone out.

The books, "A Study of the Liberal College," by Richardson and "A Modern Boy" by seven headmasters of private schools are evidences of scholars examining these questions. These books agree in the following conclusions. We have been spending too much time on the lower two-thirds of the class and neglecting the bright scholars because they seemed to take care of themselves. These talented students are the ones who will raise the general tone and temper of our intellectual life and set the pace for others. Our recent recognition of talent is of most hopeful and profound significance.

It is a recognition of the first natural law of education; to him that hath shall be given.

There are two crazes that rage in our university life, the craze of administrators for building and for expansion in every form and the craze of the students for athletics, fraternities, and distractions in every form; for the making of acquaintances that will be of use in a future business career, and for the taking of courses that will help them to get jobs on graduation. The students bring these ideals with them. We find the same giddiness and superficiality outside of the colleges. It is easy to see that the love of money is at the root of both diseases. As a remedy Mr. Richardson proposes "To raise in the great body of the students interest and ideals which will make them not scholars in the technical sense but men in whom the intellectual appeal strikes a responsive note and insures an understanding and sympathetic response—that is what is meant by scholarship. We must apply ourselves to making strong and effective and *primary* the intellectual purpose of the college.

"Such thoughts as these on education represent the crossing of a Rubicon by the American Mind." J. W. HOWARD

Science Education in China. W. G. WHITMAN. *Gen. Sci. Quart.*, **10,** 562–8 (1926).—In many of the Government schools and the Chinese private schools there is not much science taught, but in the Mission schools the quality of the work done compares favorably with the best work done in the United States. Two years each of general science and physics are given with one year of chemistry in the middle schools which correspond to the high schools in America. The language used in the Government schools is Chinese. English is used as a rule in the Mission schools although texts in both Chinese and English are available for study.

In the colleges the science work is of high order. The equipment and buildings are as good as are found in colleges of the same size in America. The instructors in some cases are Chinese and in others American. They are invariably Ph.D. men. A list of the courses given is included in the article. The science requirements for entering the leading medical colleges in China are very exacting. The China Medical Board is doing much for science education in China. It is working for better science instruction, finances research, assists in obtaining equipment, and spends large sums for science buildings at different institutions. Nanking University is the leading university of China. Much attention is given to agriculture and forestry. Science work through the university has a decided practical trend. There are pure science courses and research courses but they are only steps in the complete science program which has for its ultimate aim better conditions in China.

The Government schools are in poor condition, salaries are not paid, equipment cannot be obtained. Without the Mission schools there would be little of real value from the educational standpoint in the Chinese schools. W. R. W.

Scientific Thinking and How to Promote It in Chemical Laboratory Work. W. G. BOWERS. *Education*, **46,** 532–7 (1926).—Logically planned courses and logically arranged experiments should be followed by logically conducted laboratory work and logical teaching. The student should do his own thinking and the work should be a problem and not an exercise. A good manual and a good teacher will never tell the student what to look for but will so direct the work that the student will find the right result. Incorrect observations should be found to be incorrect by the student as the teacher directs reasoning which shows what the results of this incorrect reasoning will be. Students should not be frightened either by the teacher's manner or by a big display of emergency kits. Patience should be developed. Lack of patience leads to dishonesty. In a word, laboratory students should have their work supervised, not to save time and materials but to prevent irreparable defects in the building of a scientific thinker. O. J. S.

Honor Societies in Oklahoma High Schools. E. E. BROWN. *High Sch. Quart.*, **14,** 140–6 (1926).—Brown champions the cause of scholarship. He believes that the National Honor Society benefits school and community, and he supports his view by giving an example of a community which was thereby changed from one worshipping athletics to one honoring scholarship. He adds to his own views the opinions of seventy-five other persons who are principals in schools where that society has chapters. Brown points out that it is human to seek honors and to desire those attributes which are possessed by persons who are held in high esteem. He adds that it is not snobbishness to foster such an organization, for the ends in view are worthwhile. The National Honor Society follows Phi Beta Kappa in the manner of selecting members, but Brown believes that a better way would be to select ten per cent of each class, basing selection on scholarship. Further information regarding the National Honor Society may be

obtained by addressing H. V. Church, perennial secretary of the organization at Cicero, Ill. O. J. S.

Rock-lead, Ore-lead, and the Age of the Earth. A. HOLMES. *Nature*, **117**, 482 (1926).—If all rock-lead has been derived from the radio-active elements the time required for the disintegration is approximately 3200 million years. The atomic weight of rock-lead should be a little less than 207. The lead of commerce, which is ore-lead, is 207.2. It is therefore certain that ordinary lead cannot have been wholly derived from the radio-active elements during their terrestrial history. Since an unknown amount of the lead in igneous rocks may be ordinary lead it is clear that the earth as a radio-active container cannot have existed for so long as 3200 million years. This is in accordance with the evidence of radio-active minerals. The greatest age yet determined is that of a pitchblende from the Black Hills, S. D. The analysis indicates an age of 1525 million years and the at. wt. of the lead is 206.07. The frequently quoted figure for the age of the earth, 1600 million years, thus appears to be of the right order. From the point of view of ore-genesis, the distinction drawn between ore-lead and rock-lead is of fundamental importance. H. K. M.

Some Properties of the Vitamins. EDITORIAL. *Nature*, **117**, 522–4 (1926).—An excellent, concise review of our present knowledge of vitamins. H. K. M.

Theories of Adsorption and the Technic of Its Measurement. J. W. MCBAIN. *Nature*, **117**, 550–1 (1926).—Most of the published data on the sorption of gases and vapors have no quantitative significance because they refer to insufficiently cleaned surfaces. The behavior of a surface when cleaned from the pre-existing impurities assumes a different and highly significant form. Examples are given using charcoal in the ordinary manner and when the same surface is cleaned. In the latter case the sorption is greater and practically complete at comparatively low pressures, remaining constant at a saturation value as the pressure is further increased. The three competing theories of adsorption—the monomolecular films of Langmuir, the polymolecular films of Polanyi, and the capillary hypothesis of Gurwitsch—are discussed. The experimental results of the present paper afford almost conclusive support for the hypothesis of a monomolecular film. H. K. M.

Bigamous Hydrogen—A Protest. H. E. ARMSTRONG. *Nature*, **117**, 553–4 (1926).—"The bump of judgment seems to be lacking in the modern school of chemistry—the judicial sense is nowhere to be found. Seemingly any wild-cat speculation may be indulged in upon paper. Surely it were time that we returned to serious work in the laboratory and that some effort were made to inculcate the principles of logic into the minds of university students." H. K. M.

Mercury Helides. J. J. MANLEY. *Nature*, **117**, 587–8 (1926).—Manley has improved his technic and is now able to synthesize larger quantities of the mercury helide. His results are described at greater length than in his earlier papers. He obtains two helides, $HgHe_{10}$ and HgHe. Argon gives negative results. H. K. M.

The Geological Age of the Earth. A. HOLMES. *Nature*, **117**, 592–4 (1926).—In delivering the Robert Boyle lecture last year Prof. Joly returned to his attack on the higher estimates of geological time which have been based on the lead-ratios of uranium-bearing minerals. He favors an estimate of 160–240 millions of years for the period that has elapsed since the Archaean and refers to the lead-ratios of certain thorium minerals and to the sodium method of arriving at the age of the oceans as providing confirmatory evidence. Holmes endeavors to show that in both cases the data used are misleading and that the results from both methods can be readily interpreted to support the very estimates to which Prof. Joly considers they are opposed. H. K. M.

A Provincial Professor's Profession. G. L. DIFFENBAUGH. *Educ. Rev.*, **71**, 266–8 (1926).—A short article that lets those who are dubious see clearly why they are teaching. H. K. M.

Concrete Pipes Studied for Resistance to Soil Alkalies. With all the improvements in the use of concrete, no way has yet been found to make it completely resistant to the action of alkali soil, Dalton G. Miller, drainage engineer of the U. S. Bureau of Public Roads told the American Society of Agricultural Engineers recently.

Such pipes may be made highly resistant, however, he said, if the greatest care is taken to select the best concrete; by using a mixture rich in cement and by keeping water containing sulfates away from the pipe for as long as possible, so that it can get a chance to dry and harden in the air.—*Science Service*

Local Activities and Opportunities

University of Utah. At the University of Utah the following were appointed to Teaching Fellowships for 1926–27: Albert C. Titus, B.S., Utah '25; Howard H. Hale, B.S., Utah '26; Grover Hinckley, B.S., Brigham Young University, '25; Hilton Kellett, B.S., Brigham Young University, '26; Charles Milos, B.A., Occidental College, 1926.

Dr. Elton L. Quinn will be absent on sabbatical leave during 1926–27. He will probably spend the year at Stanford University and continue his researches on liquid carbon dioxide.

Mr. Lawrence Foster, who received his Ph.D. from Brown University this June, will be added to the chemistry staff during Dr. Quinn's absence.

The following men will complete the work for the Master's degree during the summer quarter: Charles Douglass Barnes, Briant F. Branting, Vivian B. Decker, and Bal D. Kaura. Mr. Barnes will continue his graduate work at the University of California; Mr. Branting has accepted a research fellowship at the Carnegie Institute of Technology; Mr. Decker will become Science Master in the new Weber County High School in Ogden, and Mr. Kaura plans to obtain his Ph.D. degree from an Eastern University before returning to his home in India.

The Northwestern Utah Section of the American Chemical Society at its annual election of officers, elected Dr. Charles E. Maw of Brigham Young University, *Chairman;* Dr. T. B. Brighton of the University of Utah, Vice Chairman and Dr. Corliss R. Kinney of the University of Utah, Secretary-Treasurer.

Dr. Roy F. Newton, for the past three years associate professor of metallurgical research in the University of Utah has accepted the chair of physical chemistry at Purdue University.

Princeton. Professor Lauder W. Jones left Paris, March 11th. After an interesting trip through the Balkans, Dr. Jones reached Athens on May 16th, where he spent a week before sailing for Italy.

Professor H. S. Taylor has been appointed a member of the Central Petroleum Committee of the National Research Council, representing the Division of the Physical Sciences. This Committee is charged with the duty of administering a gift of $250,000 by John D. Rockefeller, for research on petroleum.

Dr. Taylor lectured at Columbia University on July 13th. The subject of his lecture was "Catalysis and the Mechanism of Chemical Reactions," being one of the special lectures given under the head of Contemporary Developments in Chemistry, in the Summer School. Dr. Taylor also lectured at Cambridge, Mass., on June 23rd, on the occasion of the Fourth National Colloid Symposium, which was held from June 23rd to June 25th.

Professor C. L. Fleece, assistant professor of chemistry has accepted a call to Central College, Fayette, Missouri, as professor of chemistry and head of the department.

Professor N. H. Furman left Princeton on June 11th to give a course designated Selected Topics in Physical Chemistry, in the summer quarter of Stanford University.

Dr. H. K. Miller, instructor in chemistry, has been elected assistant professor of chemistry in Duke University. Dr. Miller will take up his new duties this autumn.

Dr. William Theodore Richards, son of Professor Theodore William Richards of Harvard University, has been appointed instructor in chemistry. Dr. Richards graduated at Harvard in 1920, and received the Ph.D. degree in 1924. For

the past two years he has been a Fellow in Science of the International Educational Board, and has studied at Cambridge (England), London, Copenhagen, and Paris.

Dr. T. J. Webb, Ph.D., Princeton, 1924, has been appointed instructor in physical chemistry. Dr. Webb spent the year 1924–25 as National Research Fellow at the University of California, and the year 1925–26 at Zurich as International Research Fellow in Chemistry.

Mr. James H. Hibben, Docteur-és-Sciences, University of Paris, 1924, will continue his work at Princeton the coming academic year as National Research Fellow.

Mr. Boris Bružs, Charlotte Elizabeth Procter Fellow in Chemistry, has sustained his final examination for the degree of Doctor of Philosophy, and has returned to Latvia, his native land.

Mr. H. N. Alyea, '25, was recently awarded a Scandinavian-American fellowship in Chemistry. He has sailed for Sweden to study with Dr. Hans Bäckstrom, formerly of the Princeton Graduate School. Mr. Alyea returns to Princeton in February next, as he has also been awarded a Procter Fellowship in Chemistry.

Mr. E. M. Collins, '22, has been appointed instructor in Williams College, for the coming academic year.

Dr. G. R. Burns, Ph.D., '25, Research Chemist, Dyestuffs Division of the du Pont Company, has accepted a position as instructor in Yale University.

Dr. George B. Kistiakowsky, of the University of Berlin, expects to continue, at Princeton, his research work in physical chemistry the coming academic year.

Synthetic Organic Chemical Manufacturers' Association. The Synthetic Organic Chemical Manufacturers' Association held their annual outing June 10th–12th at Briarcliff Manor, New York. There was a Board of Governors' and a general meeting. The rest of the time was given over entirely to different forms of recreation.

Neota Chemto. The Northeastern Ohio Association of Chemistry Teachers met in Cleveland, May 15th, at which time Dr. Veazey of the Case School of Applied Science spoke on "Scraps from My Note-Book." At this meeting the name of the organization was changed to "Neota Chemto" which includes both the Northeastern Ohio Teachers' Association and the Chemistry Teachers' Association. The regular Fall meeting of the Neota Chemto will be held in Lorain, Ohio, in November or December.

Science League of Philadelphia High Schools. On May 26, 1926, the student members of the combined science clubs of the Frankford High School, under the direction of their advisers, acted as hosts to student delegates from the other high schools of the city. The practice of visiting one of the high schools semi-annually was started several years ago by a number of science enthusiasts, and has continued with increasing interest since that time.

The program was unique, in that it comprised papers prepared by the students on the three major divisions of science: physics, chemistry, and biology. After presentation of the papers, there was a short business meeting, followed by an informal reception given to the visiting students in the school luncheon department. Everyone voted the afternoon highly enjoyable and profitable, and all were cordially invited by the Germantown High School representatives to be their guests at the fall meeting. The program follows:

1. Selection by the school orchestra.
2. Welcome to visiting schools (by the principal).
3. "The Life and Work of Luther Burbank."
4. Motion picture: "Communication on the Battle Front."
5. "Mechanical Refrigeration."
6. Duet—Trombone and cornet.
7. "The Rubber Industry."
8. Remarks by head of science department.

9. Business meeting.
10. Orchestra selection.
11. Refreshments.

Carnegie Institute of Technology. J. C. Warner, of Goshen, Ind., a graduate of the University of Indiana, has been appointed instructor in chemical engineering at the Carnegie Institute of Technology for the coming year. He will begin his work in September.

Dr. Warner, was graduated from the University of Indiana with an A.B. degree in 1919, an A.M. degree in 1920, and a Ph.D. degree in 1923. He has been associated as a research chemist with both the Barrett Co. in Philadelphia, and the Cosden Co. in Tulsa, Okla., and was formerly assistant manager of the Cantol Wax Co., in Bloomington, Indiana. He also served his alma mater as instructor in chemistry for two years.

Pennsylvania State College. Dr. Wheeler P. Davey of the research laboratory of the General Electric Company has been appointed professor of physical chemistry. Dr. E. R. Ries of Massachusetts Institute of Technology has been appointed associate professor of chemical engineering. Dr. Davey and Dr. Ries will devote part of their time to work in the Division of Industrial Research established by Dean G. L. Wendt last year. This organization is already carrying on several major research projects.

Prof. L. R. Parks and Mr. W. J. Sweeney have each been granted a leave of absence for the coming year. Prof. Parks plans to devote the year to research in colloid chemistry at Cornell University and Mr. Sweeney will do work in electro chemistry at Massachusetts Institute of Technology. Miss May Willard, who has been on leave of absence at Cornell during the past year, will return to Penn State next Fall.

University of Florida. Mr. Robert C. Goodwin will come to Florida in September as Assistant Professor of Chemistry, replacing Dr. H. G. Oddy, resigned. Mr. Goodwin holds the Masters degree from University of Texas and has practically completed his work for the Ph.D. at Harvard. He is a member of the American, French, and German Chemical Societies, Alpha Chi Sigma, Phi Lambda Upsilon, and Sigma Xi.

Professors T. R. Leigh, A. P. Black, F. H. Heath, and V. T. Jackson of the chemistry staff are offering courses in the University summer school, June 14th–August 6th.

Several members of the staff have returned from Jacksonville where they participated in the program of the State Pharmaceutical Association, June 16th–17th.

The College of Pharmacy announces Mr. Arnold D. Welch as winner of the competitive examination for the Groover-Stewart scholarship. This scholarship pays $1000 over a period of three years, and is awarded annually to that student making the highest record in the examinations. Present incumbents are Mr. Webster Merritt, who graduates in 1927, and Mr. J. H. Pearce, 1928.

Mercury Compounds Benefit Both Man and Trees. Mercury, which in one form or another is a specific for various human ills, is the very last word in fungicides for nursery stock.

Treatment with organic compounds of mercury during the operation of grafting apple nursery trees has been found by Department of Agriculture experts to reduce very materially subsequent infection of the stock with crown gall. Formaldehyde has been used in the past for this purpose but the more recently developed mercury compounds have proved much more efficacious in checking the spread of the fungus growth.—*Science Service*

Recent Books

Potentiometric Titrations. I. M. KOLTHOFF and N. H. FURMAN. John Wiley & Sons, New York City, 1926. xii + 345 pp. 14.5 × 23 cm. $4.50.

"Potentiometric Titrations" is a work that every chemist will welcome. The field that it covers has been the subject of many recent and valuable papers. Potentiometric analysis is a rather new tool of the greatest practical value to both the research worker and routine analyst. Some systematic and critical collection and evaluation of the means and methods so far proposed was urgently needed. Drs. Kolthoff and Furman have done this in a splendid manner.

In the very beginning a distinction is drawn between conductometric and potentiometric titrations, the former being based on the measurement of changing resistance and the latter on changing e. m. f. Both have heretofore been classed as electrometric titrations. This distinction seems wise.

The book is well-organized. The first part is devoted to a careful mathematical analysis of the theoretical principles involved. Here we find a thorough discussion of the solubility product relation, of the neutralization of acids—strong, weak, and in mixtures—of oxidation-reduction equilibria and potentials, of the general conditions for potentiometric titrations, etc. Sufficient cases are considered to enable the chemist to work out the equations for any special system that he may wish to consider. The discussion applies to ordinary titrations also.

The second part is devoted to practical applications. The various potentiometer systems and methods are described and discussed in a very thorough manner. Following this there is a discussion, with very full references, of the silver, mercury, copper, iodine, hydrogen, oxygen and air, higher oxide, quinhydrone, metal, tungsten, and glass electrodes. The last chapter deals with a large number of potentiometric oxidation-reduction reactions.

The writer wishes to commend the authors' extension of Sörensen's p_H (the ion exponent or negative log of the hydrogen-ion concentration) to ions other than hydrogen. An excellent bibliography is included in this work, as well as rather full tables of normal potentials, ionization constants, solubility products, etc.

If is to be regretted that the table of normal potentials (taken from No. 8 der Abh. der Deutschen Bunsengesellschaft, **1915**) was not amended according to R. H. Gerke's "A Summary of Electrode Potentials," *Chem. Rev.*, **1**, 377 (1925), as the latter will appear in the International Critical Tables. However, the differences are, in most cases, small. For some workers, literature references to the values given in some of the tables might prove helpful occasionally, although this can scarcely be called a criticism.

In conclusion, the writer feels that he has made a most useful addition to his library, and he is sure that teachers, advanced students, and practical workers will agree.

MALCOLM M. HARING

Introduction to Theoretical Physics, Vol. II. ARTHUR HAAS, Ph.D., Professor of Physics in the University of Vienna. Translated by T. Verschoyle. D. Van Nostrand Co., New York, 1926. x + 414 pp. 22.5 × 14 cm. $6.00.

This volume deals with that part of the field of theoretical physics not covered by the previous volume. See THIS JOURNAL, **2**, 719 (1925).

The author has succeeded in these two volumes in presenting a comprehensive survey of the whole field of modern theoretical physics in a compact, concise manner. He has done much to meet the need felt by all interested in physics, either directly or indirectly, of acquiring a knowledge of the experimental contributions made to the physical sciences in recent years and an intelligent understanding of the theories predominating in that field. The subject-matter is admirably presented, clearly and lucidly written, each step developed without omissions, without confusing the reader by the use of complicated and awesome mathematical symbols and notations, which may have hitherto deterred the layman in physics. The whole compilation shows extreme, painstaking care to render the text readable and understandable for students in any branch of science, all mathematics being expressed in terms of calculus. A synopsis of the symbols used in the discussion of each portion of the text is added for the use of the student.

These volumes form an ideal basic text either for the prospective specialist in physics, who can use it as an introduction into any specialized part of modern physics, or for students in any of the allied sciences, who are unable to keep in touch with the correlative work of the physicist. These books should prove valuable texts for class use; affording a proper perspective of the whole field of physics.

Volume II treats of the atomic theory, the theory of heat, and the theory of relativity. Under "The Atomic Theory" are discussed the elementary quantum, the theory of the hydrogen atom, Röntgen rays, the theory of the elements,

and the general theory of spectra and of atomic structure. A general chapter on "Statistics" provides an interpretation of energy as applied to the modern concepts of heat and its phenomena, discussed in the chapter on "Thermodynamics." "By resolving the object of physical processes, so-called matter, into an assembly of individual particles, it becomes possible for theoretical physics to investigate all physical phenomena and states by means of methods which are known quite apart from the province of physics as statistical methods." "The Theory of Relativity" deals with the special theory of relativity and the theory of gravitation, together with their ramifications.

In the appendix are found a summary of the whole book by sections, and a "brief summary of the more important work carried out between the publication of the German edition and of the present English edition of Vol. II."

C. G. EICHLIN

Industrial Stoichiometry. WARREN K. LEWIS, Head, Department of Chemical Engineering, Massachusetts Institute of Technology, and ARTHUR H. RADASCH, Professor of Ceramic Engineering, New York State School of Ceramics at Alfred University. First edition, 1926. McGraw-Hill Book Company, Inc., New York. xi + 174 pp. 13 figures. 15 × 23 cm. $2.50.

This volume of the McGraw-Hill Chemical Engineering Series covers the methods of making the chemical calculations involved in manufacturing processes as well as those required in design of plant and equipment. Among the subjects taken up are: Fuels and Combustion; Gas Producers; Sulfur Compounds; Lime and Cement; Furnace and Kiln Design; Metallurgy; Plant Design; and Crystallization.

As a text-book it is designed to provide means for enabling the student already versed in the arithmetic of quantitative analysis to become familiar with the technic of the more involved and difficult calculations of industrial chemistry, particularly, the computations of continuous processes. But it is meant to serve no less the man in industrial work.

The authors' names alone should vouch amply for the quality of this work and the reviewer wishes only to add that it will fill a need long felt by teachers of chemical engineering for a text-book on the quantitative aspects of the subject. It should prove particularly valuable in supplementing Walker, Lewis, and McAdams' "Principles of Chemical Engineering," with which it harmonizes in scope and methods of treatment, and it will doubtless be widely adopted by users of that text. Its appearance is an encouraging sign of the coming of other books, wherein the subject of industrial chemistry is to be given the treatment its importance warrants but which, hitherto, it has received only in small measure.

In its physical make-up—binding, paper, and type—it might well serve as a model.

H. L. OLIN

Problems in Organic Chemistry. H. W. UNDERWOOD, JR., Ph.D., Instructor in Organic Chemistry, Massachusetts Institute of Technology, Cambridge, Massachusetts. First edition, one volume. McGraw-Hill Book Company, New York, 1926. xii + 233 pp. 6 tables of properties, 97 charts of reactions. 14 × 20 cm. $2.00.

The purpose of the book is to present a series of study questions and problems which will require students to master the principles of organic chemistry and apply them to concrete cases. Although the book has been written primarily for undergraduates, it includes large amounts of material of value to graduate students.

The author has fulfilled his purpose admirably. Organic chemists of all degrees of advancement and proficiency can use the book with pleasure and profit.

From the standpoint of chemical education, the book is thoroughly sound as far as its primary purpose is concerned. However, each chapter contains introductory material which is, perhaps, open to criticism in many cases. This is partly due to an attempt to present too much material in too condensed a form and partly to what looks much like carelessness. Examples of the latter may be found in some of the applications of the Geneva nomenclature, in the misuse of terms such as "saponification" and "molecular volume," and in the consistent misnaming of Professor Crafts, one of the most distinguished chemists ever affiliated with the Massachusetts Institute of Technology.

In conclusion it should be emphasized that the book fills a definite need in a phase of organic chemistry not usually covered in so thorough or extensive a manner.

FRANK C. WHITMORE

Chemical Calculations. BERNARD JAFFE. Instructor in Chemistry, Jamaica High School, New York City. New-World Science Series, edited by John W. Ritchie. World Book Co., Yonkers-on-Hudson, New York. Cloth, xvi + 159 pp. 13 × 19 cm. $1.28.

As indicated in the preface, this book is intended to correct the deficiency found in high-school and college students in the matter of simple chemical calculations. "Both teacher and pupil are handicapped by a dearth of properly graded problems to go hand in hand with the regular daily assignment....The aim of this book is to fill the gap which teachers of chemistry in secondary schools have felt exists in most of the text-books used....Problems in this book are progressively arranged according to a number of types which the student soon learns to recognize. They are also graded according to the degree of difficulty and order of lesson assignment....

This book is designed primarily to accompany any of the more recent text-books on general chemistry. Part II has been added for use by first-year college students, and in those high schools where courses in qualitative and quantitative analysis are offered."

The material in this book is divided under three main heads, as follows.

Part I. *Type Problems.* In this part ten types are presented, such, for example, as "Valence and the Writing of Formulas," "Gases and Their Measurement," "Equivalent Weights," etc. In each case, the law or type is first defined and an example or two is solved. Following this is a set of problems of the same type. Near the end of this section is a set of miscellaneous exercises, and, finally, a list of problems taken from the New York State Regents Examination Papers, 1915–1926.

Part II. *Problems for First-Year College Students.* These problems cover such topics as "Molecular Weights," "Faraday's Laws," "Atomic Weights," "Volumetric Analysis," "Gravimetric Analysis," and are of a little more difficult type than those of Part I.

Part III. *Problems Based on Lesson Assignments.* In this section the pages are divided. At the top of each page are given type equations covering the usual topics in the usual order, and at the bottom are presented problems involving these equations.

At the end, the book contains Appendices, such, for example, as "Atomic Weights," "Conversion Tables," "Density of Acids," "Specific Heats," etc.

The problems are in general well-stated and well-graded to correspond to the students' ability. The only weakness, as the reviewer sees it, is in the definitions. The author shares with the rest of us the uncertainty about the true nature of valence. It is defined, variously, as "the capacity to unite," the "power to replace," or as a number, *e. g.*, "three." Gay-Lussac's Law of Volumes is defined thus: "The *relative* combining volumes of gases, or the volumes of their products, if gaseous, can be expressed in *a ratio of* small whole numbers." Why not leave out the words "a ratio of?" The word "relative" above implies the same thing.

The G. M. V. is given as "22.2." "A molar solution is one containing the gram-molecular weight of the solute in *1000 cc. of the solvent*," while in normal solution we have "*1000 cc. of solution.*" This makes the molar solution useless in volumetric work, and also makes it impossible to translate "molar" into "normal."

Such slight slips as have been mentioned will, no doubt, be corrected in a revision. This little volume should certainly find a place in every high-school library, and it also presents something of a challenge to the teacher of first-year college chemistry.

W. H. CHAPIN

Graded Exercises in Chemistry. MARTIN MENDEL. Globe Book Company, New York, 1926. 196 pp. 19 × 13 cm. Heavy paper cover. $0.53.

This book contains 28 chapters of well-selected and clearly stated questions suited to high-school students. Their titles correspond in substance to the titles of the chapters in any high-school chemistry text-book and each chapter is a unit directly related to its subjects. The chapters on formulas, nomenclature, types of chemical equations, and chemical arithmetic are accompanied by brief explanations which will be welcomed as clear lights on subjects usually dark to high-school pupils.

These chapters are followed by ten specimen examinations in which five groups of three questions each are given from which the pupil is to select ten questions, including at least one question from each group. These questions have a wide range, assume a thorough acquaintance with the first 28 chapters of the book and will test the ability of the student to relate chemistry to everyday life. The book closes with four tables of important physical constants.

The reviewer believes that this book is an excellent representation of the system of teaching in which a course is built around questions and that it could be used with any good high-school text. But he also believes that while this system may be an antidote for "haphazard study" it may, if relied on entirely, become an antidote for the valuable system in which a first-class teacher by *fresh* questions seeks not only to train the pupil's ability to distinguish between the important and the less important but also to direct his attention to the very latest developments in the field of chemistry. By a teacher of this kind the book may be used as a basis of review, to a less experienced teacher it may be of great value as a nucleus around which to build a course.

LOUIS W. MATTERN

Einführung in die physikalische Chemie und Kolloidchemie. H. R. KRUYT. Akademische Verlagsgesellschaft, Leipzig, 1926. xiii + 208 pp. 14.5 × 21.5 cm. M. 10.

The author states in the preface that this volume is intended to give the students of medicine and the biological sciences an insight into the principles of physical and colloid chemistry. It is the belief of the reviewer that he has admirably succeeded. It was a real and a pleasant surprise to find so much exact information condensed within these few pages.

In a clear and simple style the author elucidates the fundamental principles underlying the gas laws, diffusion, osmosis and osmotic pressure, molecular weight determinations, rates of reactions, catalysis and autocatalytic reactions, chemical equilibria and reactions in heterogeneous systems, the theories of ionization and electrolytic dissociation, ion concentration including a discussion of electrometric methods, indicators and buffers, solubility products, surface tension,

orientation of molecules on surfaces and at interfaces, adsorption, the electrical properties of colloidal systems including exact measurements of the magnitude of the electrical charges on surfaces, the optical properties of colloid systems, peptization, precipitation and coagulation, the characteristics of emulsoid sols with especial mention of the proteins, and closes with a discussion of the Donnan equilibrium and membrane potentials.

In spite of the fact that all of these items (and more) are discussed in the few pages of the volume, there are included in the text the essential mathematical formulas which it would be necessary to use in order to calculate the various physico-chemical constants from experimental data. Not only that, but as a general rule there is a complete derivation of these formulas, stated so simply that anyone with a minimum of scientific training could easily follow the theories which underlie the formulas.

There is much to commend and little to criticize. Perhaps the most surprising omission occurs in the portion devoted to the question of electrolytic dissociation, where the theories of Arrhenius and of Ostwald are stressed but no mention is made of the newer theories of Debye.

On page 181 the author explains the widely different behavior of proteins and agar as being due to the fact that proteins are capable of forming salts with acids and bases, whereas agar is a "neutral emulsoid" and consequently is not complicated by changing electrical forces. In as much as agar has been definitely shown to be the calcium salt of a substituted sulfuric acid of the formula R—O—SO_2—OH, where R is a complex polysaccharide, the idea that it is a "neutral emulsoid" will not hold, and some other explanation must be found to explain its reactions as contrasted with those of the proteins.

The essential laws of physical chemistry and of colloid chemistry are presented in this volume. Nevertheless the reviewer doubts whether there is any group in America which will profit by it. It is far too brief for use in an extended course in physical chemistry and the same statement applies to its use as a reference work, for which, of course, it was never intended as is evidenced by the fact that there are very few literature citations. It would be of great value to our medical students, but the fact that it is in a foreign language will be an impassible barrier to its use as a text in our medical schools.

ROSS AIKEN GORTNER

Chemistry to the Time of Dalton. E. J. HOLMYARD, M.A., M.Sc., F.I.C. (Science Master at Clifton College, Bristol, London). Oxford University Press, London, 1925. 128 pp. 12 × 18.5 cm. 30 illustrations. $1.00 net.

The book is a short sketch of the history of chemistry to the time of and including the work of Dalton. It is written in a readable style and for a volume of this size is one of the most satisfactory accounts of the high lights in the development of chemistry that can be put in the hands of the general student.

Chapter I, which is headed "Chemistry in Greece, Egypt, and Islam," is largely devoted to the Arabian contributions. The author is an expert in this field and has put in a concise form some very interesting data. Some of Jabir's (8th century) rules for the practice of chemistry might well be posted in the freshman laboratory of today. For instance:

(*a*) The operator should know the reason for performing each operation.

(*b*) The instructions should be properly understood.

(*c*) The impossible and profitless should be avoided.

(*d*) He must have leisure to perform his experiments, together with patience, reticence, and perseverance.

Hearsay and mere assertion, according to Jabir, have no authority in chemistry.

Chapters II and III, "Chemistry in Europe until the Fifteenth Century" afford a good resumé of that involved period which is covered at length in Stillman's "The Story of Early Chemistry."

The remainder of the text is largely devoted to the work of Mayow, Boyle,[1] Black, Cavendish, Scheele, Priestley, Lavoisier, and Dalton. These are, with two exceptions, English chemists, and the casual student might get, in consequence, a not altogether accurate perspective of the relative values of contributions outside of England. More space might well have been devoted to the great Swedish chemist, Scheele—and to others on the continent.

However, it is a very successful volume and should inspire further reading in the history of chemistry. The author, it might be said, takes an active interest in the development of School Science and in Chemical Education in England.

F. B. DAINS

Physikochemisches Praktikum. DR. A. THIEL. Sammbung naturwissenschaftlicher Praktika. Band 11. Verlag von Gebruder Borntrager, Berlin. 380 + xv pp. 16.80 Gold Marks.

There are several features of interest to be gathered from this practical physical chemistry text. From the preface, it is evident that new regulations for the *Verbands* examinations in Germany now call for examination in practical physical chemistry in addition to the traditional practical tests for all would-be *doktoranden*. The author is of the opinion that the preparation for such a test can be secured in six weeks of whole-day practical exercise. He also postulates that the exercises shall not be of the ready-pre-

[1] On page 69 there is a reproduction of the title page of the first edition of Boyle's "The Sceptical Chymist." Professor Tenney L. Davis of M. I. T. has an interesting article on this same title page in *Isis*, **8**, No. 25, 71–6 (1925).

pared variety, but that the assembly of the apparatus shall form an important feature of the exercise. The reviewer feels that these views should command consideration in physico-chemical laboratories here. The root-evil of brief three-hour periods on one or two days per week, as is common in this country, is that it leads to excessive standardization of exercises, prior preparation of apparatus by instructors and loss of real experience by the student. The author's motto is *Multum non multa*.

There are thirty-four exercises in the book in four sections: (1) on the stoichiometry of pure substances and solutions; (2) on chemical dynamics; (3) on thermochemistry and; (4) on electrochemistry. They are the classical exercises in physical chemistry with the possible exception of the measurement of dielectric constants of media by the capacity method. There are already English texts which cover these exercises as thoroughly as does the presentation in this book. One wonders whether the time is not ripe, in view of the tremendous accretions to physical chemistry, since the molecular weight-dilute solution era of the subject, for a thorough revision and extension of the course work in practical physical chemistry.

HUGH S. TAYLOR

Physics Experiment Sheets. WILLARD B. NELSON, M.S., Head of Department of Physical Sciences, Manual Training High School, Brooklyn, N. Y. Globe Book Co., New York, 1925. 128 pp., bound. 26 × 20 cm. $0.80.

The sixty experiments contained in this book are divided: 9 in hydrostatics, 15 in mechanics, 2 in magnetism, 6 in electricity, 8 in electromagnetism, and 9 in heat. Of these, 38 require the taking of quantitative data, the remaining 22 being qualitative.

These experiments are of the "stock" type for an elementary high-school course, containing: in hydrostatics, experiments on specific gravity and liquid displacement; in mechanics, on parallel and concurrent forces, moments, center of gravity, friction, simple machines, and the vibration of a pendulum; in sound, on beats and the vibration of a tuning fork; in light, on reflection from plane mirrors, internal reflection, refraction, and lenses; in magnetism, on magnetic fields of bar magnets; in electricity, on cells, Ohm's law, Wheatstone Bridge, and chemical action of a current; in electromagnetism, on the magnetic field about a conductor, and its applications to the electromagnet, electric bell, motor, telegraph, telephone receiver, and electromagnetic induction; in heat, on thermometer scales, linear expansion, specific heat, heats of fusion and vaporization, evaporation, and humidity.

"In preparing these experiments the attempt has been made to provide the pupil with directions which he will be capable of understanding with a minimum of assistance from his teacher." The instructions are confined to one-half of each page, together with the table of data for the student's use. The other half of the page is intended for diagrams (two pages of which are given as models) and answers to questions interspersed throughout the instructions. To each experiment are attached questions to be answered as a conclusion.

A page of reference tables for specific gravities, specific heats, coefficients of linear expansion, and humidity data is appended.

The experiment sheets are bound in book form with stiff covers making a permanent laboratory record.

C. G. EICHLIN

Pottery Clay Aids Cholera Cure. Kaolin, a constituent of porcelain and toilet powder, is a beneficial remedy for Asiatic cholera.

This feldspar clay, named for the Kao-Ling hills of China, has been used for centuries in that country not only in the manufacture of porcelain but by physicians for fevers and intestinal disorders. Toward the end of the nineteenth century Julius Stumpf of Wurzberg employed it externally for septic wounds and ulcers and internally for cholera. But its modern medical applications with this exception appear to have been confined, according to editorial comment in the *Journal of the American Medical Association*, to use as a filtering material, a base for poultices, and dusting powder for wounds.

Recent research puts these early uses, however, on sound scientific basis. It has been found that though it is not an antiseptic agent, in fluid media if kept in motion it will carry down large numbers of bacteria. Thirty to sixty grams daily, it was ascertained, will change materially the reaction of the intestinal contents. Medical workers in this field are now using kaolin very successfully not only for Asiatic cholera but bacillary dysentery and other acute intestinal disturbances as well.—*Science Service*

Business Manager's Page

The following two people have been chosen as winners of the contest for writing the best advertisement for the JOURNAL OF CHEMICAL EDUCATION. On the other side of this page will be noted one of the advertisements. Next month we shall include the other winning advertisement.

WINNER EAST OF THE MISSISSIPPI

BERNICE I. BECKER
Russell Sage College
Troy, New York

WINNER WEST OF THE MISSISSIPPI

SISTER MARGARET HAMEL
Providence Academy
Vancouver, Washington

EXPERIMENT (A) No. 1

OBJECT: To determine the value of "The Journal of Chemical Education"

APPARATUS: The Journals, a teacher, a student

PROCEDURE: Give the Journals to a student and teacher to read for a week

RESULTS: (Teacher + textbook → uninteresting + longfaced) Teacher + textbook + Journals → definite objectives + better methods + bubbling enthusiasm

(Student + textbook → disinterest + *D* grades) Student + textbook + Journals → curiosity + enthusiasm + scientific method + *B* grades

CONCLUSION: The Journals react with teachers and students, giving better teachers and students. They support scientific methods, open-mindedness, good citizenship and exploration. They bleach ignorance and aid interest in chemistry, thus promoting world progress.